



FEDERAL REPUBLIC OF NIGERIA

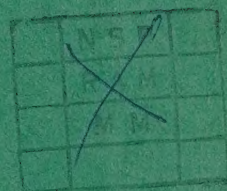
Annual Report on the Department of Agricultural Research

For the Year 1963-64

NINEPENCE NET

1968

FEDERAL MINISTRY OF INFORMATION
PRINTING DIVISION, LAGOS



**ANNUAL REPORT ON THE
DEPARTMENT OF AGRICULTURAL RESEARCH
FOR THE YEAR 1963-64**



Digitized by the Internet Archive
in 2025

FOREWORD

by

PRINCE ALADE LAMUYE, M.P.

Federal Minister of Natural Resources and Research

To-day, as in the past, the economic development of Nigeria remains primarily dependent upon the increasing productivity of the agricultural sector of the economy. This is nowhere more evident than in the necessity to increase the production of foodstuffs for a population which is now known to be increasing at a greater rate than ever before. Furthermore, with an increase expected in the percentage of the population to be employed in industry, it is essential that the productivity of the farms and the farming community be increased as soon as possible.

The investigations carried out by the Federal Department of Agricultural Research in the fields of crop improvement, crop protection and crop nutrition can assist the farmer by providing materials, techniques and knowledge to enable him to increase the yield of every acre he cultivates.

It is essential, of course, for these new materials and advances in technique to be demonstrated to the farmer. It is therefore gratifying to note that the Department maintains the closest collaboration with the extension workers of the Regional Ministries of Agriculture. For results which have been achieved, I wish to express my appreciation to the officers of the Department for their devotion to duty.

CONTENTS

	<i>Pages</i>
Foreword By the Honourable Minister of Natural Resources and Research	1
Chapter I Report by the Director of Agricultural Research	7
Chapter II Report on the Agronomy Division	14
Maize	14
Cowpeas	16
Soyabeans	17
Other Grain Legumes	17
Evapotranspiration	17
Chapter III Report on the Botany Division	19
Maize	19
Plant Introduction	20
Citrus	21
Kola	22
Avocado	23
Mango	23
Grain Legumes	24
Chapter IV Report on the Chemistry and Soils Division	25
Soil and Plant Analysis	25
Spectro-Chemistry	25
Experiments on Crop Nutrition	26
Chapter V Report on the Entomology Division	29
Yam Beetles	29
Cowpea Pests	30
Sweet Potato Weevil	31
Fruit Flies (Trypetidae)	32
Thrips and Mites of Citrus and other Economic Plants	32
Arthropods Associated with Rhizobium Nodules	32
Insects Associated with Coconut Palms	32
Chapter VI Report on the Plant Pathology Division	33
Plant Disease Survey	33
Mycology	33
Virology	34
Bacteriology	35
Chapter VII Report on the Rice Research Unit	36
Plant Breeding	36
The Naturally Inundated Lowlands	36
The Non-Inundated Irrigable Lowlands	37
The Rainfed Uplands	39
Agronomy : Shallow Swamp Rice	41
Agronomy : Upland Rice	44
Milling Studies	45

CONTENTS—*continued*

	<i>pages</i>
Chapter VIII Report on Root Crop Research Unit	47
Plant Breeding : Yams	47
Plant Breeding : Cassava	49
Plant Breeding : Sweet Potatoes	53
Agronomy of Root Crops	53
Yams	53
Cassava	57
Sweet Potatoes	58
Coco Yams	59
Chapter IX Report on the Statistics and Records Division	60
Statistics	60
Records	60
A Summary of the Results of the 1932 Rootstock Trials on Moor Plantation	61
Chapter X Report on the Plant Quarantine Service	64
Stations	64
Plant Importation	64
Plant Exportation	64
Staff Training and U.S.A.I.D. Assistance	64
Chapter XI Report on the Library	65
Library Service	65
Publications	65
Scientific Journals	65
Memoranda	66
Appendices I Moor Plantation, Rainfall Data 1963	67
II Moor Plantation, Sunshine Data 1963	67
III Moor Plantation, Evaporation Data 1963	68
IV Moor Plantation, Temperature Data 1963	69
V Badeggi, Meteorological Data 1963	70

FEDERAL DEPARTMENT OF AGRICULTURAL RESEARCH

SENIOR STAFF LIST—31ST MARCH, 1964

Director of Agricultural Research	.. ..	G. E. O. Okiy, B.sc. (Ord.), B.sc. (Hons.) Edin.
Deputy Director of Agricultural Research		J. E. Y. Hardcastle, B.Sc., D.A.S., D.T.A.
Personal Secretary	.. ..	M. K. Fogarty (Miss)
Senior Accountant	.. ..	W. A. Daniju
Higher Executive Officer (Acting)	.. ..	S. B. Alalade
Librarian	.. ..	N. I. Shinie (Miss), B.Sc. (Edin.) A.L.A.
Principal Research Officers	.. ..	F. A. Squire, B.Sc., A.I.C.T.A. C. H. Obihara, B.Sc., A.I.C.T.A. B. D. A. Beck, B.Sc., D.A.S., D.T.A.
Senior Research Officers	.. ..	C. L. M. Van Eijnatten, Li. A. W. Waitt, B.Sc. (Hons.), D.A.S., D.T.A. P. M. Chinwuba, B.A., B.Sc., M.Sc. A. G. Bailey, B.Sc., D.A.S., D.T.A. D. G. Robertson, M.A., D.A.S.
Research Officers	.. ..	J. A. F. M. Sluyters, M.sc. (Agric.) M. N. Nwaji, B.Sc., Ph.D. T. J. Bredero, Li. M.Sc. S. A. Mabadeje (Mrs), B.Sc., Ph.D. B. Afonja, B.Sc. F. O. C. Ezedinma, B.Sc., M.Sc. J. H. G. Ticheler, B.Sc., M.Sc., Ph.D. C. N. Ifeagwu, B.A., M.Sc. D. Archibong, B.Sc., M.Sc. S. S. Patil, B.Sc., M.Sc., M.S., M.F.
Research Officers-in-Training	.. ..	S. O. Boboye, B.Sc. M. N. Okafor, B.Sc., Ph.D. E. N. Ugochukwu, B.Sc. M. Nwagwu, B.Sc. A. O. Anya, B.Sc. P. E. Onuorah, B.Sc. S. D. Agboola, B.Sc. O. O. Ojehomon, B.Sc. B. O. Njoku, B.Sc. V. A. Azih, B.Sc. B. A. Okwakpam, B.Sc. M. O. Aluko, B.Sc. T. O. Fadayomi, B.Sc.
Superintendent Laboratory Technologist	.. ..	S. O. Olojedo-Nelson, A.I.S.T., M.R.I.C.
Technical Officers	.. ..	J. K. Olurin, Cert. Agric. M. J. Ekandem, Cert. Agric. M. N. Okparanta, Cert. Agric. E. A. Dosunmu, Cert. Agric. Dip. Agric. J. A. Obi, Cert. Agric., Cert. Agric. (Kew). A. A. Ononokpono, Cert. Agric. E. U. Edem, Dip. Agric. G. N. Nwoffiah, Cert. Agric. M. C. Ezediokpu, Cert. Agric.

Station Managers	..	..	..	..	S. A. Soremi, Cert. Agric. T. O. Agulana, Cert. Agric.
Laboratory Technologists	..	..	..	..	S. N. Muotoe, A.I.S.T., Cert. Agric. S. V. A. Ajomale, A.I.S.T., Cert. Agric. E. S. Page (Miss), A.I.S.T.
Executive Officer (Accounts)	..	..	..	..	B. G. Onwuegbusi.
Mechanical Demonstrator	..	..	..	..	M. A. Bankole, D.A.E. (Grade I Agric. E., Dip. Agric. F., Cert. Prof. Agric E.)

ANNUAL REPORT ON THE DEPARTMENT OF AGRICULTURAL RESEARCH, FOR THE YEAR 1963-64

CHAPTER I

REPORT BY THE DIRECTOR OF AGRICULTURAL RESEARCH

Introduction

During the period under review the policy of the Department remained unchanged ; the research programme proceeded along the same lines of investigation as in the previous year.

There were a few increases in the establishment and the recruitment showed slight improvement in all the cadres of staff but there were still many vacancies to fill in the Department.

A Departmental Research Reviewing Committee was initiated and the first annual meeting was held in December 1963 ; the object of this Committee, which is made up of all Research Officers in the Department, is to give the research workers in the various fields the opportunity to review the progress of research in the Department and to suggest areas where co-operation in the research projects is desirable and feasible. It also affords the Department an opportunity to assign degrees of priorities to the various projects on the research programmes.

The Department is grateful to many international bodies and other Ministries for their assistance and co-operation ; particularly to the Rubber Research Institute of Malaya for allowing Mr R. A. Fox to visit Nigeria at the request of the Department to carry out most valuable investigation on the outbreak of root diseases of rubber. There was a close collaboration between this Department and the Regional Ministries of Agriculture and effective efforts were made through the Agricultural Technical Committee to obtain necessary co-ordination in the research programmes of all agricultural research organisations maintained with public funds in this Federation.

Visitors and Visits

Distinguished visitors to the Headquarters, Field Experiments and Laboratories at Moor Plantation, Ibadan to see the work in progress and for discussion during the period, include the following : Mr T. V. Anderson, World Bank ; Mr H. Fougere, F.A.O., Rome ; Mr J. Hartough, Niger Delta Development Board, Port Harcourt ; Mr Louis Caresche, Scientific Secretary of the Inter-African Phytosanitary Commission ; Dr Vernon C. Johnson and several U.S.A.I.D. officials ; Mr C. Akhurst, F.A.O., Rome ; Mr N. A. Nwosu, Chief Inspector of Agriculture, Eastern Nigeria ; Mr W. C. Bedding, UNTAB, Lagos ; Mr M. T. Zwankhuczen, FAO/ECA, Addis Ababa ; Hon. M. M. Ngobi, Minister of Agriculture and Co-operatives, Uganda ; Mr C. W. Hartley on leaving WAIFOR, Benin City ; Mr A. A. Ayida, Permanent Secretary, Ministry of Economic Development, Lagos ; Mr J. Lomas and Mr J. M. Babalola, Agrometeorologists ; W. T. Chang, Institute of Botany, Taipei Republic of China ; Professor H. S. Darling, Institute for Agricultural Research, Samaru ; Dr W. M. Hamilton, New Zealand ; I. G. Harrar and R. Brafield, the Rockefeller Foundation, New York ; D. Heayes and F. Hill, the Ford Foundation, New York ; Mr D. B. Murray of the University of West Indies ; D. R. E. Jackson, Agricultural Adviser, Enugu ; Dr L. H. Greenwood Barton, Tropical Products Research Institute, London ; Miss Elizabeth Owen, Royal Commonwealth Society, London.

Visitors to the Rice Research Station, Badeggi, include Hon. F. U. Mbakogu, Parliamentary Secretary, Federal Ministry of Economic Development, Mr W. S. Bates, U. K. Deputy High Commissioner ; Hon. J. A. Unwuchola, Provincial Commissioner, Ilorin ; Mr N. A. Akingbehin, Director, Meteorological Services, Lagos ; Dr H. I. Oka, National Institute of Genetics, Japan.

The Rootcrops Research Unit, Umudike was visited by the following ; Dr the Hon. Nwoye Otue, Minister of State for Agriculture, Eastern Nigeria ; J. Papadakis, F.A.O., Accra ; H. E., Mr C. T. O'Conor King, Liberian Ambassador to Nigeria ; Sir Geoffrey Nye, Department of Technical Co-operation, London and Mr A. F. W. Sheffield, ex-Director of Agriculture, Eastern Nigeria.

Owing to the suspected outbreak of *Armillaria* root disease of rubber in one rubber estate at Calabar, Mr R. A. Fox of the Rubber Research Institute, Malaya was invited by this Department to visit Nigeria. He visited the main rubber growing areas of Calabar in Eastern Nigeria, and Benin and Sapele in Mid-Western Nigeria and spent some time at Moor Plantation for discussion, before returning to Malaya. He later submitted a report on his findings.

Conferences

On the invitation of the FAO, Mr G. E. O. Okiy, Director of Agricultural Research attended the World Food Congress held in Washington D.C. from the 4th to the 18th of June, 1963 and read a paper on "Experience with the Freedom from Hunger Campaign Fertilizer Programme in Nigeria".

The Director seized the opportunity of his visit to Washington D.C. for the World Food Congress to see the USDA Research Centre at Beltsville and the Land Grant University of Maryland. He also accompanied Alhaji the Honourable Waziri Ibrahim, Federal Minister of Economic Development, on his visit to parts of Canada and Trinidad. During these visits he seized the opportunity to see the Agricultural Research Centres and study the organization of Agricultural Research in the countries visited and submitted a report on the subject.

A symposium on soil, organised by the FAO Agricultural Mission and the Agricultural Society of Nigeria, for officers working on soils in Nigeria was held in April at Moor Plantation.

The 13th and 14th Meetings of the Agricultural Technical Committee was held under the Chairmanship of the Director of Agricultural Research in August 1963 at Moor Plantation, and in February 1964 at Zaria, respectively.

Mr G. E. O. Okiy, Director, was among the Nigeria delegation which attended the XIIth biennial Conference of FAO in Rome from 6th November to 5th December, 1963 ; he also attended the annual Congress of the Science Association of Nigeria held at Samaru, Zaria from 18th to 21st December, 1963 and read a paper on "The Role of Research on the Development of Nigeria Agriculture".

Representatives of the Department attended the regional cropping conferences as well as Managing Committee meetings of W.A.I.F.O.R. and WACRI. The Director also attended the Board meetings of the Agriculture Faculties of the Universities of Ibadan and Ife.

Departmental Heads of Divisions Meetings were held quarterly and the first meeting of the newly started Research Reviewing Committee of the Department was held at Moor Plantation in December 1963.

Staff

Mr G. E. O. Okiy, Director of Agricultural Research was on vacation leave from 27th December, 1963 to 17th February, 1964 when Mr F. A. Squire, Principal Research Officer acted for him and Mr J. E. Y. Hardcastle acted as Deputy Director. Mr C. H. Obihara, Senior Research Officer transferred on promotion to the Department as Principal Research Officer and was put in charge of the Chemistry and Soils Division. Dr (Mrs) S. A. Mabadeje, Research Officer (Mycologist) returned to the Department on the completion of her post-graduate studies at the University of Ibadan as was also Mr B. Afonja, Research Officer (Statistician) who returned from the University of Aberdeen. Mr S. N. Muotoe, Laboratory Technologist, returned from the Macaulay Institute, Aberdeen where he was trained on how to operate spectrographic units.

The new officers who joined the Department included Messrs D. Archibong (Plant Breeder), O. O. Ojehomon (Plant Physiologist), V. A. Azih (Agronomist), S. D. Agboola (Bacteriologist) and B. O. Njoku (Chemist), M. O. Aluko (Plant Pathologist), B. O. Okwakpam (Entomologist), S. S. Patil (Rice Breeder) and Mr S. O. Olojede-Nelson (Superintendent Laboratory Technologist).

Messrs P. E. Onuorah and O. O. Ojehomon, S. D. Agboola and B. O. Njoku, Pupil Research Officers, left for Cambridge, Nottingham and Aberdeen Universities respectively to undertake their post-graduate studies. Messrs Onuorah and Ojehomon held a scholarship under the U.K. Technical Assistance Scheme for Commonwealth countries. Messrs E. A. Dosunmu and J. A. Obi, Technical Officers, attended the U.S.D.A. Course in Plant Quarantine at Washington D. C. and New York from April to June 1963. Mr S. V. A. Ajomole, Assistant Laboratory Technologist returned from in-service-training at the University College, Ibadan in Laboratory technology and resumed duty in June 1963.

The officers who left the Department included Messrs B. N. Webster (Deputy Director), I. C. Burrige, M. H. D. F. Fyfe and Dr T. A. Taylor and J. A. F. M. Sluyters, Acting Senior Research Officers. Dr J. Takahashi, U.N.T.A.B. Expert and Mr A. Vaillant F.A.M.A. Expert completed their assignments at the Rice Research Station, Badeggi in 1963 and left the country.

The authorised establishment of Senior Staff at the beginning of the year and the actual strength at 31st March, 1964 are given below :—

Administrative and Professional

							<i>Establish- ment</i>	<i>Filled</i>	<i>Vacancies</i>
Director	..	..	..	..	..	..	1	1	—
Deputy Director	..	..	..	..	..	..	1	—	1
Principal Research Officers		..	..	..	..	..	5	4	1
Senior Research Officers and Research Officers	..	..					41	30	11
Librarian	..	..	..	..	..	..	1	1	—
Total Administrative and Profesional Staff	..	..					49	36	13

Executive (Technical) Higher Technical Staff

Technical Officers	..	..	..	..	..	..	11	9	2
Assistant Technical Officers		..	..	..	..	..	16	10	6
Chief Laboratory Technologist	..	..	..	..	..	..	1	—	1
Superintendent Laboratory Technologists		..	..				3	1	2
Laboratory Technologists		..	..	..	..	..	5	3	2
Assistant Laboratory Technologists		..	..	..	..	..	9	1	8
Station Managers	..	..	..	..	..	..	2	2	—
Mechanical Demonstrator	..	..	..	..	..	..	1	1	—
Total Executive (Technical) Higher Technical Staff	..						48	27	21

Executive (Administrative)

	<i>Establishment</i>	<i>Filled</i>	<i>Vacancies</i>
Senior Accountant	1	—	1
Higher Executive Officer	1	—	1
Executive Officer (General)	1	1	—
Executive Officer (Accounts)	1	1	—
Assistant Executive Officer (General)	2	1	1
Assistant Executive Officer (Accounts)	2	1	1
Records Officer	1	—	1
Personal Secretary	1	1	—
Total Executive Staff	10	5	5
Grand Total Senior Staff	107	68	39

The authorised establishment of Junior staff at the beginning of the year and the actual strength at 31st March, 1964 are given below :—

Clerical

	<i>Establishment</i>	<i>Filled</i>	<i>Vacancies</i>
Chief Clerk	1	1	—
Assistant Chief Clerk	2	2	—
First-class Clerks	11	7	4
Second and Third-class Clerks	23	20	3
Library Clerks	2	1	1
Stenographer, Grades I and II	2	2	—
Store Keeper, Grade I	1	—	1
Store Keeper, Grades II and III	1	1	—
Total Clerical Staff	43	34	9

Technical

Senior Agricultural Assistant, Grade I	1	1	—
Senior Agricultural Assistants, Grade II	4	2	2
1st Class Agricultural Laboratory Technician	2	2	—
Agricultural Assistant, Grade I	11	5	6
Agricultural Assistant, Grades II and III	62	42	20
2nd and 3rd Class Agricultural Laboratory Technicians	9	8	1
Photographic Assistant, Grade I	1	1	—
Draughtsman, Grade II	1	1	—
Total Technical Staff	91	62	29

Minor Technical and Sub Clerical

Senior Field Overseers	7	7	—
Field Overseers, Grades I and II	56	56	—
Artisans	12	12	—
Drivers-Mechanics	10	10	—
Clerical Assistants	13	12	1
Typists	11	11	—
Meteorological Recorder	1	1	—
Total, Minor Technical and Sub Clerical Staff	110	109	1

Minor Technical and Sub-Clerical

					<i>Establishment</i>	<i>Filled</i>	<i>Vancacies</i>
Senior Laboratory Attendant	..	..	..	..	1	1	—
Laboratory Attendants	..	..	..	..	7	5	2
Stores Attendant	..	..	..	..	1	1	—
Head Messenger	..	..	..	..	1	1	—
Messengers	..	..	..	..	13	11	2
Total Minor Technical and Sub-Clerical					23	19	4
Grand Total Junior Staff					267	224	43

Progress of Nigerianisation as at 31st March, 1964

					<i>Nigerian</i>	<i>Expatriate</i>	<i>Vacant</i>	<i>Total</i>
						(P)	(C)	
Administrative and Professional	..	..	..	..	24	6	6	49
Executive (Technical)	..	..	..	..	27	—	—	48
Technical	..	..	..	..	62	—	—	91
Minor Technical	..	..	..	..	109	—	—	110
Executive (Clerical)	..	..	..	..	5	—	—	10
Clerical	..	..	..	..	34	—	—	43
Sub-Clerical	..	..	..	..	19	—	—	23
					280	6	6	374

(P) = Pensionable.

(C) = Contract Terms.

Nigerians undertaking higher training at the present time to qualify themselves for posts in the Department are as follows :—

<i>Subject</i>					<i>Number of Students</i>				<i>Total</i>
					<i>Diploma</i>	<i>B.Sc.</i>	<i>M.Sc.</i>	<i>Ph.D.</i>	
Agriculture	..	..	..	..	—	6	—	—	6
Botany	..	..	..	..	—	2	—	—	2
Chemistry	..	..	..	..	—	1	—	—	1
Mathematics	..	..	..	..	—	—	—	—	—
Zoology	..	..	..	..	—	—	—	—	—
Plant Pathology	..	..	..	..	—	—	—	1	1
Microbiology	..	..	..	..	—	—	—	1	1
Agronomy	..	..	..	..	—	3	—	—	3
Physiology	..	..	..	..	—	—	—	—	—
Entomology	..	..	..	..	—	—	1	—	1
					—	12	1	2	15

The Weather and Crops

The rains were excessively heavy during July, August and September 1963 and were about double 10 years' average on Moor Plantation. This caused the river Ona to overflow its banks by about 45 feet on either side. The bridge over the river was torn off and improvised canoes were used to cross from one side to the other and Moor Plantation was for several days isolated from Ibadan. Experimental fields and nurseries on the Station were badly eroded and crops were damaged or carried away by the floods. The rains for October and December were also above 10 years' average but there was intense drought in November which adversely affected field crops.

Spectrographs

The setting up of two spectrographic units was completed during the period under review but there was no Spectrographic Chemist available to utilise the facilities thus provided as the chemist who set up the unit left the Department on the completion of this contract. However, with the return of Mr Muotoe, Laboratory Technologist, who was sent to the Macaulay Institute, Aberdeen to study the operation of spectrograph, preliminary work on the calibration of spectrographic plates, preparation and design of electrodes and purification of reagents for spectrographic work was started. Mr B. O. Njoku, Research Officer was sent to Aberdeen University during the period to do his post-graduate course and specialise as a Spectrographic Chemist. When a Spectrographic Chemist becomes available in the Department, these units will carry out analysis for any research establishment in Nigeria which may require the service for the analysis of plant products and soils. The present practice in sending such materials abroad for analysis will then cease.

Armillaria Root Disease of Rubber

Owing to suspected outbreak of Armillaria root disease of rubber caused at one of the rubber estates in Calabar, Eastern Nigeria, Mr R. A. Fox of the Rubber Research Institute, Malaya, visited Nigeria in May 1963 in response to the request of this Department to his Institute. Mr Fox visited the rubber growing areas of Calabar in Eastern Nigeria and Benin and Sapele in Mid-Western Nigeria, to inspect rubber plantations. He subsequently produced a report* in which he confirmed the presence of the root disease caused by the fungus, *Armillaria mellea*. This is the first time Armillaria root disease of rubber has been confirmed in Nigeria. Mr Fox also identified and recorded a number of other root diseases due to such casual agents as *Fomes lignosus* (Klotzsch) Bres; *Fomes noxius*, Corner, *Ganoderma pseudoferreum* (Wakef.) van Over et Steinm., *Sphaerostilbe repens* Berk et. Br.*

Rust on Wheat

There was a severe outbreak of stem rust on wheat in Northern Nigeria and about 70 per cent loss in yield was recorded at Hadejia. This was the first record of the disease in Nigeria. On the request of the Ministry of Agriculture, Northern Nigeria, to this Department, Mr A. G. Bailey, Federal Plant Pathologist, visited the area to carry out an investigation; he subsequently submitted a report on the situation.

Statistics and Records

On the return of Mr Biyi Afonja to the department after his post-graduate training at Aberdeen, a section for statistics and records was established. This section will render statistical service to all the Divisions of the department and help them in the design and analysis of their experiments. The records section will maintain the experimental records of the department and the duplicate experimental records submitted by Regional and other agricultural research bodies in Nigeria in accordance with the decision of the Agricultural Technical Committee at its XIV meeting.

Rice Research

This work continues to show encouraging progress. The department has now found several varieties of rice higher yielding than BG 79 and these are recommended to replace the latter in suitable places. Some of these varieties such as MAS 2401 and D114 are already being issued by this Department to the Regional Ministries of Agriculture for multiplication and subsequent distribution to farmers for growing. Many recommended rice varieties were introduced from other countries through our Plant Quarantine Service and these are being grown and studied in different parts of Nigeria.

*Document 27 of Research Archives of Rubber Research Institute of Malaya.

The leaf blasts caused by the fungi *Pyricularia oryza* and *Helminthosporium oryzae* are causing severe losses of yield in the rice crop. In the breeding programme great importance is attached to resistance to leaf blasts. From the experiments conducted, the rice variety, Tjina, has shown a very high degree of resistance to this disease and will be used in the breeding programme.

With the establishment of the new rice sub-stations of Birnin Kebbi in Northern Nigeria, Bende in Eastern Nigeria and Warri in Mid-Western Nigeria, it is intended to expand the research programme on swamp rice in all the Regions. The work on upland rice in Western Nigeria is supervised from Moor Plantation, Ibadan. These sub-stations are supervised from the main Federal Rice Research Station at Badeggi in Northern Nigeria.

Crop Pests

The work on yam beetle which is a most devastating pest on this important food crop was temporarily suspended with the resignation of Dr Taylor from this Department to take up appointment at the University of Ibadan. In addition to the efforts of the Department to recruit a suitable entomologist to carry on this nationally important project, an arrangement is being made to utilise the services of the Commonwealth Institute of Biological Control in the investigation of the biological control of this pest in accordance with the decision reached at the XIV meeting of the Agricultural Technical Committee. From the investigations carried out at the sugar cane plantation at Bacita, a number of pests have been found to be attacking this crop ; these are stem borers and Dynastid beetles. Although damages due to these pests are not yet severe, yet it is necessary to keep up the study in order to be able to devise control measures for the pests, if the need arises.

Nigerian Grain Legume Gene Bank

The first Nigerian Grain Legumes Conference was held at Samaru, Zaria in December 1963 under the Chairmanship of Professor H. S. Darling. Among the recommendations which it made was one for the establishment of a Cowpea Gene Bank by this Department. This recommendation was considered at the XIV meeting of the Agricultural Technical Committee and was approved. Accordingly Mr D. Archibong, Legume Breeder, with a few junior staff of this Department was posted to Samaru, Zaria to initiate the Nigerian Grain Legume Gene Bank project before the end of the period under review. He will work in close association with the Northern Region's Institute for Agricultural Research.

Plant Introduction Service

This service was established in October 1963 for the purpose of organising the introduction of economic crops to Nigeria ; it works closely with plant breeders and the Plant Quarantine Service of the department. It will also maintain the collection of indigenous economic plants and keep an up-to-date record of all the economic plant introduced through the department into Nigeria.

G. E. O. OKIY,
Director of Agricultural Research

CHAPTER II

REPORT ON THE AGRONOMY DIVISION

MAIZE

Co-operative Maize Yield Trials

During the 1963 season, 38 maize performance trials were located at various important maize growing centres in the country. The primary objective of these trials was to study and select a variety or varieties best suited to the specific ecological zones. As the performances of maize varieties might not be fully assessed from a single year's results or from a single location due to fluctuating environmental conditions, it was decided that varieties to be recommended for release should yield consistently high over a period of 4 years. The first phase of co-operative yield trials which were started in 1960 was therefore completed in 1963.

Besides a popular local variety which was included as a tester in each location, all other varieties entered in the trials were introduced from other countries.

Results for 1963 trials were essentially similar to those of the previous years. Local varieties were in general lower yielding than the introduced varieties. With the exception of two locations (Mubi and Akwanga in Sardauna and Plateau Provinces respectively) where local varieties performed as high as introduced varieties, there was no evidence of variety x location interactions. In other words, a variety that performed well in one location also did well in other locations. Two varieties, E.S.1 and Eafro 231, gave exceptionally consistent and good yields in most locations. A detailed report summarizing the results for 1963 trials is being prepared.

Variety Recommendations

A variety is ready for release and distribution to farmers when it has been proved to be distinctly superior to other varieties in at least one respect, and also when found satisfactory in other important respects.

In areas where corn meal is not generally popular or where a large quantity of the maize produced is used as livestock food, priority is usually given to yield performances when recommendations are made. However, in a country like Nigeria where over 90 per cent of the maize grown is used as human food, high yield alone is not sufficient and the milling quality and palatability have to be taken into account.

Tests upon milling quality and palatability in various areas in Nigeria have shown that variety Eafro 231 is one of the best varieties for making "EKO", "TUWO" or "AGIDI". E.S.1 has also been popular because of its high sugar content which makes it suitable for consumption in the fresh state as "corn on the cob". Being yellow grained it is also valuable as livestock and poultry feed.

In view of the above facts these two varieties, Eafro 231 and E.S.1 have been recommended for multiplication and distribution throughout the whole country.

The initial stage of multiplication of E.S.1 has already been started in all the regions and it is hoped that the seed will be available for release by 1965. Seed of the Eafro 231 has also been distributed to regions in quantities sufficient to commence multiplication with a view to distribution by 1965.

Drought Resistance Studies

In an attempt to discover a maize variety or varieties that could escape drought injury and or tolerate to a greater extent the unfavourable conditions of drought, 6 early-maturing introduced varieties and a local variety (Lagos White) were entered in a yield trial in the 1963 season.

The plants received abundant moisture during their early stages of development. But a dry spell which started 57 days after planting and lasted throughout the remaining part of the season adversely affected the crop. The performances of the maize varieties are summarized as follows :—

The Performances of 7 Early Maturing Maize Varieties

<i>Variety</i>	<i>Tasseling Time (days)</i>	<i>Silking Time (days)</i>	<i>Yield (lb/acre)</i>
Lagos White	57	60	2,245
Eafro 251	47	50	1,468
Eafro 235	48	50	1,360
Eafro 242	48	51	1,339
Eafro 239	51	54	1,308
Eafro 257	53	57	1,210
Eafro 258	55	58	500

According to the above results, Lagos White was significantly superior in yield to other varieties. There were no significant differences in yields between Eafro 251, Eafro 235, Eafro 242 and Eafro 239. Eafro 251 was, however, significantly superior to Eafro 257 and Eafro 258.

The tendency for Lagos White to perform better than late maturing varieties in the late seasons has often been assumed to be due to the fact that it is early enough to mature even in the shorter seasons. As it matured later than other varieties entered in this trial, it must have been exposed to dry conditions longer than these varieties. The good yield of Lagos White under drought conditions, may therefore, be primarily due to its inherent capacity to tolerate drought rather than to its tendency to mature safely in late seasons.

Date of Planting Studies

Experiments were carried out at Mokwa and Badeggi to determine the optimum planting dates. It was originally planned to plant the first maize soon after the first rains (1" or more) and the subsequent ones at two weekly intervals. The original plan was actually carried out at Mokwa but due to physical difficulties the first planting at Badeggi was not done until about 3 weeks after the first rain. Maize variety, Trinidad, was used in both experiments. Results of the experiments are shown below :—

Yield Performances of Maize Planted at Various Dates at Mokwa and Badeggi

MOKWA			BADEGGI		
Planting Date		Yield (lb/acre)	Planting Date		Yield (lb/acre)
24-4-63	..	1,717	20-5-63	..	2,140
8-5-63	..	2,989	3-6-63	..	1,810
25-5-63	..	2,047	17-6-63	..	1,264
5-6-63	..	1,773	1-7-63	..	820
Mean Yield (lb/acre)		2,132	Mean Yield (lb/acre)		1,309
C.V. (%)		14	C.V. (%)		19
L.S.D. at 5 % (lb/acre)		478	L.S.D. at 5 % (lb/acre)		461

At Mokwa a significant increase in yield was obtained from the second planting. Maize planted on the first date (two days after the first rain) gave the lowest yield probably because the soil was not yet stabilized when the planting was done. Delayed planting after the 8th of May resulted in progressively decreasing yields. Similar relations were observed at Badeggi where planting done 3 weeks after the first rain gave the highest yield. The crop dropped sharply in yields as planting was delayed 5 weeks after the first rain. No definite conclusion on the optimum planting date for Badeggi could, however, be made until all essential dates have been included in similar and future trials.

Fertilizer Trials

Experiments were conducted at Mokwa, Badeggi, Ilora and Ibadan in 1963 to study the response of maize to applications of nitrogen, phosphorus and potassium.

The applications of 40 lb of nitrogen per acre produced increases of 600, 750, 1,306 and 1,437 lb of dry grain at Mokwa, Badeggi, Ilora and Ibadan respectively. Further increase in yield from 1,392 to 1,997 lb/acre was achieved at Badeggi with additional application of 40 lb/acre of nitrogen. There was little or no response at other locations with additional applications of 40 lb/acre of nitrogen.

Higher response to phosphorus (P^2O^5) were observed at Mokwa, Ibadan and Ilora where 40 lb of P^2O^5 per acre gave average yield increases of 290, 477 and 1,243 lb per acre respectively. Phosphorus did not affect yields at Badeggi.

No appreciable yield responses at any of the locations could be attributed to potassium applications.

COWPEAS

Daylength Observations

Observations carried out on 300 cowpea varieties of all growth forms showed that about 65 per cent of the trailing types failed to flower within 90 days when planted in April (long days) whilst all the varieties flowered within 50 days when planted in September (short days). Most of these varieties which exhibited a short day reaction are of Nigerian origin. The seed qualities of Nigerian varieties are generally preferable to those of exotic varieties. The association of desirable seed qualities with short day reaction among local varieties has consequently confined the production of the commercial varieties of cowpeas to the late cropping season. Causes are being made between the indigenous and introduced varieties of desirable seed type to obtain varieties which will also be well adapted to both early and late seasons.

Yield Components

Growth form appeared to be an important factor affecting the pattern of reproduction in cowpeas. Marked dissimilarities were observed in the flowering and pod setting of the upright, semi upright and trailing growth forms. Also, the various shoot components of these growth forms, showed differences both in their flowering and pod setting as well as in their respective contributions to final yields. The contribution of the primary shoot was highest in the upright growth form and lowest in the trailing type. On the other hand, the secondary shoots of the upright variety contributed relatively less to final yield than similar shoots on the semi upright and trailing varieties. The significance of these observations in the day length response of these growth forms is being studied.

Fertilizer Trials

Fertilizer experiments on early and late season cowpeas at Ibadan showed that fertilizers applied at planting resulted in more vigorous growth, earlier full bloom, enhanced maturity and higher proportion of beans at first harvest than later applications. There were no yield differences due to methods of fertilizer application. Higher vegetative vigour and yield of beans were, however, obtained where fertilizers were placed 5-10 cm. away from the plant. Positive responses to nitrogen and phosphorus were obtained on early and late season cowpeas but optimum rates of application have not yet been determined. There were indications, however, that cowpeas require the major nutrients but probably at low dosages.

Spacing and Plant Population Trials

Results of early and late season trials suggested that the optimum spacing for cowpeas would lie between 2.0 and 3.5 square feet per plant. Rows three feet apart with plants spaced one foot within the rows gave the best results in both seasons. There was evidence that the best result would be obtained by thinning the plants to one per hill at the one leaf stage. The vegetative vigour, as measured by the total dry matter yield at different stages of growth, as well as yield of beans, were inversely proportional to the number of plants grown per hill. A population of 14,520 plants per acre at one plant per hill appeared to be the optimum of semi upright cowpeas.

SOYABEANS

Spacing and plant Population Trials

Results of early and late season trials indicated that the optimum area was less than one square foot per plant or more than 43,560 plants per acre at one plant per hill.

Soyabean production in the forest belt may, however, be limited by the heavy damage done by rodents to the growing plants at the seedlings stage. Usually, the seedlings do not develop normally after their leaves have been clipped by rodents.

Other Grain Legumes

Collections of other Nigerian grain legumes including Pigeon pea, Yam beans, Bambara groundnuts and Lima beans are being increased for future tests. There is very little information as yet on their agronomic characteristics and it is proposed that these indigenous species which are considerably important in the diets of people in several districts should be studied in greater details.

EVAPOTRANSPIRATION

In the 4th quarter of 1963 maize was grown in four out of the seven plots used for evapotranspiration studies. Two of the cropped plots were mulched and the other two were left unmulched. Of the remaining three plots, one was mulched, another was left bare and the remaining one, which was the standard plot, was planted to bahama grass.

The following totals for the growing cycle of maize—12th September—31st December (i.e., 111 days) represent the amount of water lost by evapotranspiration from a soil kept at field capacity.

Bahama grass	..	..	..	432.7mm.=17.3 inches
Bare soil, ridged	..	..	..	431.0mm.=17.2 inches
Mulched soil, ridged	..	..	..	150.1mm.= 6.0 inches
Maize, mulched, ridged	..	..	..	680.3mm.=27.2 inches
Maize, unmulched, ridged	..	..	..	1,030.4mm.=41.2 inches

It is clear from the above figures that the application of mulch greatly reduced the evapotranspiration. Mulching could be of great advantage to crops which might suffer from drought as is reflected in the yield of the plots. The mulched plots yielded an average of 1,710 lb, of maize grains at 12 per cent moisture content as against the unmulched plots 1,375 lb, per acre. It should be noted that the plots did not receive additional water.

The results of the first quarter of 1964 are being analysed. Up-land rice will be grown on part of the plots in the early season 1964.

CHAPTER III

REPORT ON THE BOTANY DIVISION

MAIZE

New (Synthetic) Varieties

Two new synthetic varieties were added to the stock of the Maize Breeding Section. These were designated by the experimental code NS-4 and NS-5 respectively. NS-4 was constituted from a number of high combining S-4 inbred lines derived from local Nigerian floury varieties. NS-5 was constituted from these same inbred lines of local floury varieties and a few inbred lines of white dent varieties—Mexico-5, and Sicaragua. It was hoped to combine the high yield of these dents with the flouriness (soft endoplasm) of the local Nigerian varieties in the new synthetic.

The third generation (recombination) of these synthetics was produced towards the end of the year and seeds were given to the Senior Agronomist (Maize) for entry in the Co-operative trials of yield and general performance in the 1964-65 seasons.

Production of Inbred Lines

A start was made during the early season to produce a new series of inbred lines of Lagos White, Mexico 5, Sicaragua and Eafro 231. These varieties were found by previous tests to possess high combining abilities. The S2 (second generation) inbred lines of the varieties have been produced to date and this will be continued until the S4 inbreds are produced which will then be put into tests of combining ability in topcross trials. Following these preliminary tests, a further stage of the breeding programme will be initiated.

Production of High-Yielding Floury Varieties

In-breeding and selection for good combining inbred lines were continued during the year on four local white floury varieties, Lagos White, Bende White, Bende Local and Ugep White. This programme is aimed at eventually producing a high-yielding floury synthetic variety from the best combining S4 inbred lines. This will continue in 1964-65.

Investigation of Flintiness in Lagos White

This investigation which was aimed at finding out the reason for the occurrence of flinty grains in Lagos White inbred material, went through the third generation. The indication was that the flintiness was caused by contamination and the project was concluded.

Development of Blight-Resistant Variety

Seventeen inbred lines selected on the basis of their blight-resistance from nine local varieties were bulked and grown for the first time in an isolation plot in the late season of 1963. The programme will continue for a number of generations. It is hoped to concentrate their germ plasms and increase resistance in the new variety.

Production of Topcrosses

A series of topcrosses involving S4 lines of the white varieties, Lagos White, Mexico 5, Sicaragua and Eafro 231, were produced in the early season. Topcrosses involving yellow S1 inbreds of Tsolo with NS-1 as tester were also produced. The topcrosses were put in yield trials in the late season for a test of their combining ability.

Mokwa Breeding Programme

During the late season, 1,296 inbred lines from 19 varieties at Mokwa were sent to Ibadan for sibmating. The object is to develop varieties ecologically suited to the Northern Nigeria environment. It is considered a saving in research time to do the late season work on Moor Plantation since this is not possible in the North. The materials will be returned to Mokwa for the last inbreeding stage during the early season of 1964/65 prior to a more complicated breeding exercise.

Eastern Nigeria Breeding Programme

During the year, tours were undertaken to Eastern Nigeria by the Research Officer (Botanist) and Technical Officer (Agriculture) for the purpose of surveying and collecting local dry grain types of maize. These were necessary preliminary investigations, preparatory to initiating a breeding programme for Eastern Nigeria. In the 1964/65 year, preliminary observation plots are planned at Umudike and Ikom respectively, if funds permit.

General

The flood of August 1963 destroyed about one-third of the crop of NS-5 synthetic variety growing on Moor Plantation. Much bird damage to the experimental maize crop was also experienced in both seasons.

The early on-set of dry season in the late planting season adversely affected a number of plots. Drought commenced about the time the plants were forming ears. There was therefore lack of moisture for the normal development of plants.

PLANT INTRODUCTION

The Plant Introduction Service was established last October (1963), as an arm of the Botany Division. It then took over responsibility for matters pertaining to the introduction of economic plants into Nigeria, the horticultural work and post-entry quarantine duties which hitherto were the responsibility of the Plant Quarantine Service. Other duties assigned to the new Section included maintenance of economic plant collections; a rubber clonal budwood nursery, a coffee collection and the distribution of plant materials from Moor Plantation.

The following gives a summary of the activities of the Section from its formation on 1-10-63 and covering the last six months of the 1963/64 year that it was in existence.

Plant Introduction and Quarantine

This part of the Section's work was carried on in very close co-operation with the Plant Quarantine Service.

Fifty-six consignments of economic plant materials consisting of sixty species and involving about 469 varieties were imported by Government agencies and research institutions during the period. Twenty-two of these consignments were grown in quarantine before being released to the importers.

The bulk of the imports were for cocoa, seeds of fruit trees such as guava, loquat and kumquat; fibre crops such as ramie, hibiscus and cannabis; sorghum; rubber; rice; sugarcane and seeds of forest trees.

Records

The following list of introductions were compiled by the section for distribution to interested parties :—

(a) List of Plant Introductions, 1962.

(b) List of rubber clones in Nigeria and their distribution on 31-12-63.

(c) List of sugar cane varieties in Nigeria and their distribution.

(d) List of Plant Introductions, 1963.

(a) and (b) above were mimeographed and circulated as Departmental Memoranda Numbers 63 and 64 respectively.

A start was made with the revision of the Plant Introduction records with a view to bringing them up to date. This project is still in progress and should be completed shortly.

Buildings

The construction of an all-purpose plant quarantine greenhouse which could withstand the variation in local conditions was proposed. It was also planned to replace the existing vinyl screening on screen houses, which was found to deteriorate rapidly under local conditions, with copper screening and tanalised wood.

A proposal to extend the present Plant Quarantine building to provide for a soil store was put forward but could not be carried out before the end of the 1963/64 financial year because of lack of funds.

Economic Collection Plots

These plots suffered severe damages during the 1963 floods ; whole plots were washed away while some were completely buried under sand. The affected plots were replanned and planted up with cover while crops that showed dislike for flooding were removed to plots above the flood level.

Fifty one varieties of imported plant materials were added to the collection while 118 varieties, consisting mainly of grasses, were supplied to outside bodies.

A collection of indigenous fruit trees was started. Additions will be made to these from time to time.

Rubber Budding Trials

A rubber budding trial was started to investigate the effects of using thinner stocks than the scionwood. Scionwood of $1\frac{1}{4}$ inches in diameter was used on stocks of (a) equal diameter ($1\frac{1}{4}$ inches), (b) smaller diameter ($\frac{3}{4}$ inches).

Twelve buddings were made on each type of stock at fortnightly intervals. From the results so far obtained there appears to be no significant difference between the effects of the two sizes of stock used on the success of the budding. The experiment was continued.

CITRUS

Citrus Trials

The five trials planted in 1955 were continued, namely (i) an Agege 1 Sweet Orange Root Stock trial, (ii) a replicate of this Sweet Orange Root Stock trial with the extra addition of Rangpur Lime root stock, (iii) a Lemon Root Stock trial, (iv) Acid Lime Root Stock and (v) A sweet Orange Varietal Trial. Most of the Rangpur Lime stocks in the Acid Lime Root Stock trial died back ; the few that survived remained stunted in growth and generally lacked vigour. Girths, heights and canopy spread of each plant in the experiments were taken to determine the growth to yield ratio. Correlation between these are yet to be calculated.

New Citrus Collection

This new collection accommodates all the citrus varieties formerly given in the old collection, now discontinued and other varieties more recently introduced. All were budded on the recommended root stocks, namely Cleopatra mandarin (MY186), Willow leaf mandarin (MA71) and Lake tangelo (MY35).

During the later part of the year, replacement of transplanted but unsuccessfully budded seedlings was carried out. The total number of plants in this new Collection stood at 192 at the close of the year.

Citrus Nursery

A large number of successful budding operations were carried out during the year. It was hoped that this will be sufficient to meet the demands during the next year. Many more root stocks were planted in preparation against next budding season for both Citrus and Avocado pear.

KOLA

Moor Plantation Observations

To facilitate the expansion of the Kola programme, increased attention was given to providing planting materials, in the form of rooted cuttings, selfed and cross-pollinated seedlings. The materials were taken from selected high yielding red gbanja kola trees, *C. nitida*, at Agege.

Propagation.—Rooting of kola cuttings proved very successful. With the exception of one, AF112, all the other selected trees were successfully rooted. In addition a few cuttings of *C. nitida* taken from Labochi, and others, including *C. acuminata*, taken from Igala Division, were successfully rooted. By the end of the year, a total of 1,551 successfully rooted cuttings had been produced. However there was still much room for improvement in technique.

Production of Hybrid seedlings.—Sixty-six per cent of the hybrid seedlings, produced from the seeds of various crosses at Agege, emerged at the end of 92 days at Moor Plantation. The seeds were first planted in germinating trays filled with washed river sand (as the germinating medium) and covered with polythene sheeting to make a humid atmosphere. The criterion for determining germination of seedlings was the emergence of the radicles followed by the plumules a few days after potting. The germinated seeds, totalling 2,080, were later transferred into larger baskets filled with a mixture of four parts of rich surface soil and one part of compost. These were placed in the shade to develop.

Shade versus no Shade Observation.—Interesting results were obtained from the 120 rooted Kola rootstock cuttings, planted at Moor Plantation, one half with shade and the other half without shade at Moor Plantation. Fifty-four of the sixty plants in the shade looked more robust, and healthy and generally were less attacked by insects, as the leaves were whole, fresh and green; six of the plants in this plot were not doing too well. Of the other sixty plants without shade, twenty-one were healthy; twenty plants attacked by insects; six were badly attacked; five plants were badly defoliated; three were yellowing and five plants died back.

Kola Observations, Ina Farm

The dry season was unusually serve and prolonged. The development of the rooted Kola cuttings planted at Ina in 1963 was consequently affected. With the exception of one or two mild showers, no rain of appreciable quantity fell at Ina during the last three months

of the dry season. The covers provided by *Tephrosia*, *Pueraria*, and palm fronds, were not sufficiently effective. As a result, severe damages occurred, especially among the plants raised from rooted cuttings. It was significant that the seedlings in the progeny trials planted in September, within the same field, stood up to the dry season with no loss of plants, except in a single isolated case.

Shade versus no Shade Observations.—As on Moor Plantation, the preliminary results obtained from this trial were interesting. Plants grown without shade looked less vigorous. A few of the seedlings showed stunted growth, producing pale-green leaves with crinkling edges. The rate of leaf shedding in both the shaded and unshaded replications appeared to be proportional to the amount of shade provided. Counts made for leaf drop in three densities of shade gave the following results :—

LEAF SHED	
<i>Densities of Shade (per cent)</i>	<i>Number of Fallen leaves</i>
75.00	363
25.0	518
0.00	619

Agege Farm Observations

Observations on yields of the selected tree were carried out. Special attention was also paid to producing selfed and cross pollinated seeds.

The small trials planted in 1962, using rooted cuttings of three high yielding trees AA62, AA86 and AA231, made encouraging progress. The first yield of five pods, containing twenty-seven nuts and weighing 270 grammes, was harvested from the cross pollination carried out between one of these trees, AA86 and AA269. The nuts were resown.

AVOCADO

Six of the sixty trees, selected for yield and under observation on Moor Plantation, died from drought. At one time or the other it was necessary to do hand-watering particularly with such trees that were either in bloom or laden with fruits. Some eighteen trees remained sterile but yield recordings were taken on those trees that fruited.

Production of Rootstocks

After a rather disappointing start, the seedling stocks raised on Moor Plantation early in the year made a satisfactory progress. Several of the plants are now large enough for budding. Propagation of the more promising lines will be carried out as soon as selection is completed in the year.

MANGO

Six budded Julie Mangoes, reputed to be dwarf and ball shaped were introduced from Yandev. These were planted in the Fruit Tree Collection. The following varieties of Mango are now on Moor Plantation :—

<i>Varieties</i>	<i>Source</i>
Julie	Ex Ilorin
Julie	Ex Yandev
Aephonse	Ex India
Pitter	Ex India
Borsha	Ex Ogbomosho

Hindi Sinnor
Nabrouka
Tay-mour
Peach
Bukuru A
Bukuru B

Zaria
Zaria
Zaria
Zaria
Bukuru
Bukuru

GRAIN LEGUMES

A plant breeding programme for edible legumes, with special emphasis on cowpeas, was commenced during the later part of April 1963 when Mr D. Archibong was appointed as a legume breeding specialist on his return from the United States of America. At this time, the Federal Agronomist was maintaining a collection of 320 cowpea varieties. This collection was taken over and detailed observations continued to aid the legume breeder in making selections for future breeding work.

Green House Investigation

Observations taken on these cowpea plots indicated that the incidence of cowpea diseases and pests was very high. One of the major problems confronting the legume breeder initially was how to grow healthy cowpea plants, free from field pests attacking the flowers, in order to produce hybrids. A review of the literature gave no clue as to the best growth media suitable for green house cowpea cultures.

A growth media experiment was designed to ascertain the proportions of surface soil, river sand and artificial fertilizer (N.P.K.) which would give the most desirable cowpea growth. The preliminary results showed that a mixture which contained three parts of surface soil, one part of river sand and 250 lbs per acre of NPK (20 : 20 : 20) gave the best growth under green-house conditions. It was then hypothesized that the volume of soil (pot size) played some part in limiting the growth. An experiment was carried out to test this hypothesis. The data taken on six characters significantly showed that there was a positive relation between pot size and the cowpea plant vigour. The results of this experiment will be written up for publication.

With the conclusion of these two experiments, the legume breeder was able to plan the production of cowpea hybrids in the green house.

Field Research

Field investigations on cowpeas yielded very poor results throughout the year. This was due to a high rate of incidence of insect pests attacking the foliage and floral parts of the plant. The most prevalent of these were *Maruca*, *Ootheca*, and *Laspeyresia* spp. High incidence of virus disease on the plots was also observed.

Through the aid of chemical spraying (Gammalin 20, Dieldrex and Dimicron 50) the cowpea plots were maintained in fairly clean and healthy state of growth and thus enabling the legume breeder to make selection of 50 varieties from the total of 320 for inclusion in the 1964-65 yield trial comparison.

During the year a variety of Guar (*Cyamopsis* spp.) was acquired and used to determine the effect of direct seeding versus transplanting methods on the mean expression of some of its traits. The result of the trial indicated that the plant height, number of leaves, number of flower clusters and yield per plant were significantly greater when seeded than when transplanted. The results will be prepared for publication soon.

At the end of the period under review the legume breeder was transferred to Samaru, Zaria to initiate the Nigerian Grain Legume Gene Bank project.

CHAPTER IV

REPORT ON THE CHEMISTRY AND SOILS DIVISION

SOIL AND PLANT ANALYSIS

The general review of the methods of chemical analysis of soil and plant material and the establishment of standard techniques and methods were carried out. Many new laboratory technicians were recruited and trained in these techniques owing to the large expansion in the scope and volume of the work of this Division during the year.

Several hundreds of soil and plant samples were analysed regularly as a part of several research projects on soil fertility, on fertilizer experiments, with maize, cowpeas, rice, tobacco, yams and cassava, on soil classification studies, and on experiments with grass, legume, and tree fallows.

A few hundred soil samples were also analysed in connection with investigations on potting mixtures, the examination of the sites and soils of various Federal Agricultural projects, and the study of the soils of various areas used for research projects.

Some plant analysis of maize leaves in a study of maize nutrition were carried out by the Physiology Section of the Botany Division, which in December handed over work on nutrition studies and plant analysis to the Chemistry and Soils Division.

SPECTROCHEMISTRY

The large and medium quartz spectrographs were set up in fully air-conditioned rooms at the beginning of this period. The spectrographic laboratory was complete with a densitometer laboratory for reading and measuring spectrographic lines, a lathe room for the preparation of electrodes, a dark room for developing the plates, a spectrographic balance room, an oven and preparation room, and a spectrographic chemistry laboratory.

The rest of the year was used in the preparation and design of electrodes, the purification of solutions, reagents and samples to spectroscopic standards, the preparation of spectrographic plates and in the usually slow process of calibration.

Preparation and Design of Electrodes

Two types of electrodes were tried out, the split graphite rod electrode and the porous cup electrode. The porous cup electrode has been found more satisfactory and has been adopted for regular use in this laboratory. The two electrodes are described below.

The Graphite Rod Electrode

A graphite rod $\frac{3}{16}$ inch in diameter having a fairly smooth end whose plane is normal to the length of the rod has a central slit $\frac{1}{4}$ inch long made in it by means of a saw whose cutting blade is $\frac{1}{40}$ inch thick. This rod is inserted into a polythene funnel $1\frac{1}{2}$ inches wide at its wide end and $\frac{3}{4}$ inch wide at the base with a stem $\frac{3}{4}$ inch long, and is held in place by means of small pieces of polythene tubing which also act as a stopper for the funnel. The slit end of the rod which forms the lower electrode is polished smooth on filter paper. The counter electrode consists of a similar graphite rod whose end has been fashioned into a cone with an included angle of 70° , and is separated from the lower electrode by 2 mm. The lower electrode is placed so that its upper end is about 2 mm. above the top of the polythene cup. The solution under study is poured into the polythene cup until its level is just above the bottom of the slit in the lower electrode. The solution is thought to be transported to the top of the electrode by means of capillary attraction.

Using this electrode system which was devised by Burrige (personal communication) we have found that results obtained are not consistent. Thus in sparking, solutions which have been obtained by diluting a stock solution sometimes give denser spectrograms than the more concentrated solutions. We have therefore attempted to make porous cup electrodes.

The Forous Cup Electrodes

These electrodes originally devised by Feldman (1949) consist of graphite rods which have a hole drilled to within 0.6 mm. of the smooth closed ends. This forms the upper electrode and contains the solution under examination. A pointed graphite rod forms the lower (counter) electrode. Results obtained with these electrodes are consistent, and further they have the advantage of consuming only minute amounts of solutions. We are handicapped in the preparation of these electrodes by not having the proper tools for drilling to within 0.6 mm. of the base of the cups and for checking the thickness of the base of the cups. In the method at present in use a graphite rod 5.50 cm. long is held in the chuck jaws of a Myford lathe and is drilled with an $\frac{1}{8}$ inch drill which has only 5.44 cm. of its length exposed. The cups are heated in an oven at 450° for 2 hours before use to make them more porous.

Preparation and purification of reagents for the spectrograph

Conventional laboratory reagents even of A.R. quality are not sufficiently pure for spectrographic analysis. The following reagents were prepared and purified during the period :

- Aluminium oxide
- Calcium carbonate
- Sodium carbonate
- Ferric oxide
- Nitric acid
- Hydrochloric acid
- Acetic acid
- Purified ammonia

Calibration of Spectrographic Plates

A spark spectrum of Iron was produced by using nails as electrodes in the medium quartz spectrograph. The optical densities and transmissions of the three steps of 15 lines were measured. These values were converted to Seidel densities with which a preliminary curve was drawn (for an analogous method using optical densities *see* Churchill (1944) from this preliminary curve a graph relating the Seidel density of the lines to log-relative exposure was obtained. This was transformed into an emulsion characteristic curve, which has a gamma value 1.18 to 1.19.

EXPERIMENTS ON CROP NUTRITION

Maize

Moor Plantation.—Soil samples were taken and the soils examined in March from the site of Nutrition experiments on maize. Attempts are to be made to relate the soil status to the growth and yield of the crop. The effects of added fertilizers is also to be investigated.

Agege.—In addition to the normal nutritional investigations about the supply and the effects of nutritional elements, it was realised that fertility in Agege was lowered by the intense acidity in an excessively—leached sandy soil. A 3⁴ NPK Ca factorial trial was to be laid on at the beginning of the rains towards the end of this period that is in April.

In March the site was examined, soil samples were taken for analysis, and the line was applied factorially at 3 levels.

Mokwa and Badeggi.—These two sites fall within the same climatic zone in the Middle Belt and have been classified in the same soil series. Yet the performance of the same maize varieties in similar experiments on the two sites were usually quite different. Soil samples from both sites were examined and analysed.

The difference in soil fertility status which are most likely due to management and agronomic history, were reflected in significant variations in the status of organic matter, the concentration of exchangeable calcium and in the soil reaction. All these factors are critical in maize nutrition.

At Mokwa, the pH is higher, the concentration of exchangeable calcium is higher, the carbon-nitrogen ratio is lower, the soil is more plentifully supplied with organic matter. For figures please see Table 1 below :—

Table 1.—Maize Soils at Mokwa and Badeggi

Place			Lab. No.	Normal Reaction (pH)	Organic Carbon %	Exchangeable Calcium %	Total Nitrogen %	C/N R
Badeggi	..	..	S 11	6.0	2.35	0.039	0.23	10.2
			S 12	7.1	2.39	0.039	0.23	10.4
			S 13	6.3	1.95	0.032	0.33	6.0
			S 14	5.04	2.30	0.045	0.23	10.0
			S 15	4.75	2.41	0.026	0.33	7.7
Average	..	..		5.8	2.3	0.036	0.27	9.0
Mokwa	..	..	S 16	6.74	3.82	0.039	0.34	11.3
			S 17	7.9	4.63	0.050	0.31	14.9
			S 18	7.75	4.68	0.091	0.34	13.8
			S 18	7.74	5.02	0.086	0.33	15.2
			S 20	7.52	4.48	0.060	0.22	20.4
Average	..	..		7.5	4.5	0.065	0.31	15.1

Long Term Grass Fallow Trial: Moor Plantation

This experiment was designed to test the effect of the system of management of a grass fallow species on the build-up and maintenance of soil fertility in the type of soil and under the climate prevalent at Moor Plantation.

(a) 4 years grass fallow followed by 4 years cropping

(b) 4 years grass ley followed by 4 years cropping

(c) Continuous cropping.

The cropping is cassava, maize, maize ; cassava, maize, maize.

Fertilizers are applied at 2 levels of P and K and 3 levels of N. The experiment is laid, out in 96 plots in 10 acres.

Cassava.—Cassava planted in 1962 was harvested after 14 months in September 1963. Average yield was over 17 tons per acre and was good. No significant effects were however obtained between the various treatments. This was however neither expected nor regrettable since the experiment was still in the first phase of the first cycle and no treatment had been completed.

Some other differences that were observed are discussed later under the heading of "Some other fertility trends".

Late Maize.—Maize was planted in September and harvested in January. The performance of the maize plants was generally poor and yields were low. Average yield was 82 lbs dry grain per acre with ES1. All plots were mulched with maize residues after harvest. These were dug in during cultivation in the middle of March when the plots were prepared for early maize.

The reasons for this low yield were an early attack by stem-borers, the low precipitation over this period that was insufficient for the optimum needs of the maize plant and above all the low state of soil fertility to which these plots have been reduced after 50 years of incessant cropping as part of Moor Plantation. It is interesting that this long-term experiment on the build-up and conservation of soil fertility should start on soils at such a low ebb of fertility. As in the cassava trials, no significant effects were observed between the various treatments.

Some Other Fertility Trends

Though not significant, the maize yields referred to above showed trends that seemed to reflect the previous history of the site. The site had been used for various purposes and experiments in the past and it is not intended to over-stress this aspect of the experiment. Other factors too might have contributed largely to the results obtained, apart from the one given below.

But the site in the 5 years immediately preceding the start of the experiment *i.e.* up to the middle of 1962, was under various grass species. Each grass species was maintained in the same area during this period although stands of absolute purity were not always obtained.

The maize and cassava yields have been examined in relation to these grass species and the results are tabulated in Table 2. The results are listed in a descending order of magnitude. Only the last species, *Andropogon gayanus*, is included in the 5 species that are being tried out for this experiment (Expt. No. XIIIB1.1)

Table 2—Effect of earlier grass species on Cassava and Late Maize yields : Mean Yields in lbs per acre

<i>Grass Species</i>	<i>Maize</i>	<i>Cassava</i>
<i>Cynodon plectostachyum</i>	1,108	40,768
<i>Cenchrus ciliaris</i>	897	36,736
<i>Panicum bambatsi</i>	829	39,424
<i>Erograstis curvula</i>	701	37,856
<i>Andropogon gayanus</i>	565	36,512

It seems safe to conclude that the areas originally occupied by these fallow species are arranged in a descending order of productivity in the above Table. The agreement between the Cassava and the Maize crops grown at different times of the year is striking. This reflects the present state of soil fertility. It is not however so safe to ascribe these differences solely to the effect of these grass fallow species on the maintenance or restoration of soil fertility, because the soil fertility status of the plots was not measured initially. These plots have a 50 year history of continuous farming and other factors of previous management could be contributory.

In any case these differences in basic soil fertility exposed in the field used for this 96 plot experiment have to be taken into account, in interpreting and analysing results obtained in the future.

Comparative Trial of Fallow Species : Moor Plantation

This experiment is designed to investigate the suitability as fallow species, in the long term maintenance of soil fertility under the soils and climate typified by Moor Plantation, of the following 5 species :

- (a) *Penninsetum purpureum*
- (b) *Panicum maximum*
- (c) *Andropogon gayanus*
- (d) *Tripsacum laxum*
- (e) *Stylosanthes gracilis*.

The fallow species were laid out in strips separated by contoured bunds and each was replicated 5 times. The grass plot size was 84 feet x 24 feet.

Nitrogen fertilizer is applied at 3 levels broadcast at the start of the rains after the grass is cut to a uniform height of 12 inches.

The grass is to be cut three times during the growing season at 12 weekly intervals. The fertilizer is to be applied on these three occasions.

From recent observations it could be seen that the ease and rate of establishment was in the following order :

- 1. *Panicum maximum*
- 2. *Penninsetum Purpureum*
- 3. *Andropogon gayanus*
- 4. *Tripsacum laxum*
- 5. *Stylosanthes gracilis*

After establishment, *stylosanthes gracilis* shot off and was soon vegetating luxuriantly. It attained a height of 51 inches in a plot less than 6 months after seeding. The best over-all performance to date was shown by *Penninsetum purpureum*.

Long-term Acioa Fallow Experiment : Waifor, Benin City

This experiment was designed to test the effects of the long term maintenance of soil fertility of varying lengths of *Acioa barteri* fallows. The index of fertility is 2 years cropping and soil studies. The experiment is laid out in 224 plots in 35 acres and is in full progress.

So far no significant differences have been observed of the effect of length of fallow on the soil productivity for annual crops. This cannot mean that none are likely to be obtained in future or that the other perhaps more fundamental aspects of this experiment, such as the effect of fallow length, on the soil, which are only just starting, will not yield significant results.

CHAPTER V

REPORT ON THE ENTOMOLOGY DIVISION

YAM BEETLES

Studies on the bionomics and control of yam beetle species in Nigeria continued. Observations on feeding—migration flights of the beetles at Asaba and Agenebode have shown the flight period to lie between 9th April-22nd June. During this period, a total of 197 beetles were caught, 173 of which were *Heteroligus meles* and the rest *Prionoryctes canaliculus*. In laboratory cultures at Moor Plantation, Ibadan, the adult beetles remained quiescent deep down in the soil with very little feeding taking place. This confirmed the field observation that much of the time spent in the yam mounds is in a resting phase and that most of the feeding takes place immediately prior to the breeding migration.

Preliminary observations on the flight behaviour of the adult yam beetles during the period of migration were carried out. Two methods of marking the beetles were employed. Filing the prothorax proved unsuccessful because the beetles died during the first 24 hours after being marked in this manner. Removing a small triangular portion of the right elytra posteriorly proved more reliable. Although very few beetles were marked, 25 per cent of the marked ones were subsequently recaptured at the light trap. This gives an indication that at least a proportion of the yam beetles fly on more than one night, and possibly on many nights during the period of migration. Insectary studies with beetles kept in moist soil in 22-gallon drums and supplied with yam setts for feeding, came to the top of the soil and attempted to fly around on several night during the migratory period. In nature, therefore, it is possible that redistribution of the beetles within the yam plot could occur as a result of subsequent flights after the mass migration of post-teneral adults. It was observed that *Prionoryctes canaliculus* did not exhibit this flight behaviour.

Control Experiments

The results of the yam beetle control experiments at Ogoni and Agenebode showed at least, at Ogoni where the attack rate was fairly high, that the application of Aldrin to the setts and soil at planting was more effective than the application to either sett or soil alone. Further details of the analysis of the figures obtained are still expected. It was difficult to make any deductions from the results of the experiment at Agenebode as the attack rate was very low.

COWPEA PESTS

Work on the field pest of Cowpeas continued. Regular collections of insects associated with the crop showed that on the whole the same groups of insects as in previous year, except for a few new species, were responsible for the damage on the different stages of the growing cowpea plant. Over 60 pest species of varying economic importance have been encountered. Among the major pests are *Maruca testulalis* Gey. (Pyralidae) and *Laspeyresia ptychora* Meyr. (Tortricidae). It is now established that the usually low yield and poor quality produce obtained from the crop is at least partly attributable to heavy insect attack in the field.

Control Experiments

Two insecticidal trial experiments were conducted at Moor Plantation in 1963. The first was on upright and trailing types of cowpeas planted on 8th May. In this experiment spraying on the upright type plots was started on 5th June that is 4th week from planting, while that on the trailing type plots was started on the 5th week. The treatments were the same. The following insecticides were used :—

- A. Dieldrin 20 per cent E.C. at 1/10 pt/gallon of water.
- B. Gammalin 20 per cent E.C. at 1/10 pt/gallon of water.
- C. Telodrin 15 per cent E.C. at 1/10 pt/gallon of water.
- D. Sevin 5 per cent W.P. at $\frac{1}{2}$ lb/gallon of water.

Frequency of application.—Dieldrin 20 was sprayed weekly from 4th to the 10th week. Gammalin 20 was sprayed at alternate week from the 4th to 10th week. Sevin 5 per cent W.P. was only applied on the 4th, 7th and 10th weeks and Telodrin 15 per cent on only the 5th and 9th weeks.

The second experiment was a pilot experiment with Dimicron 50—an organophosphorus systemic as an additional insecticide.

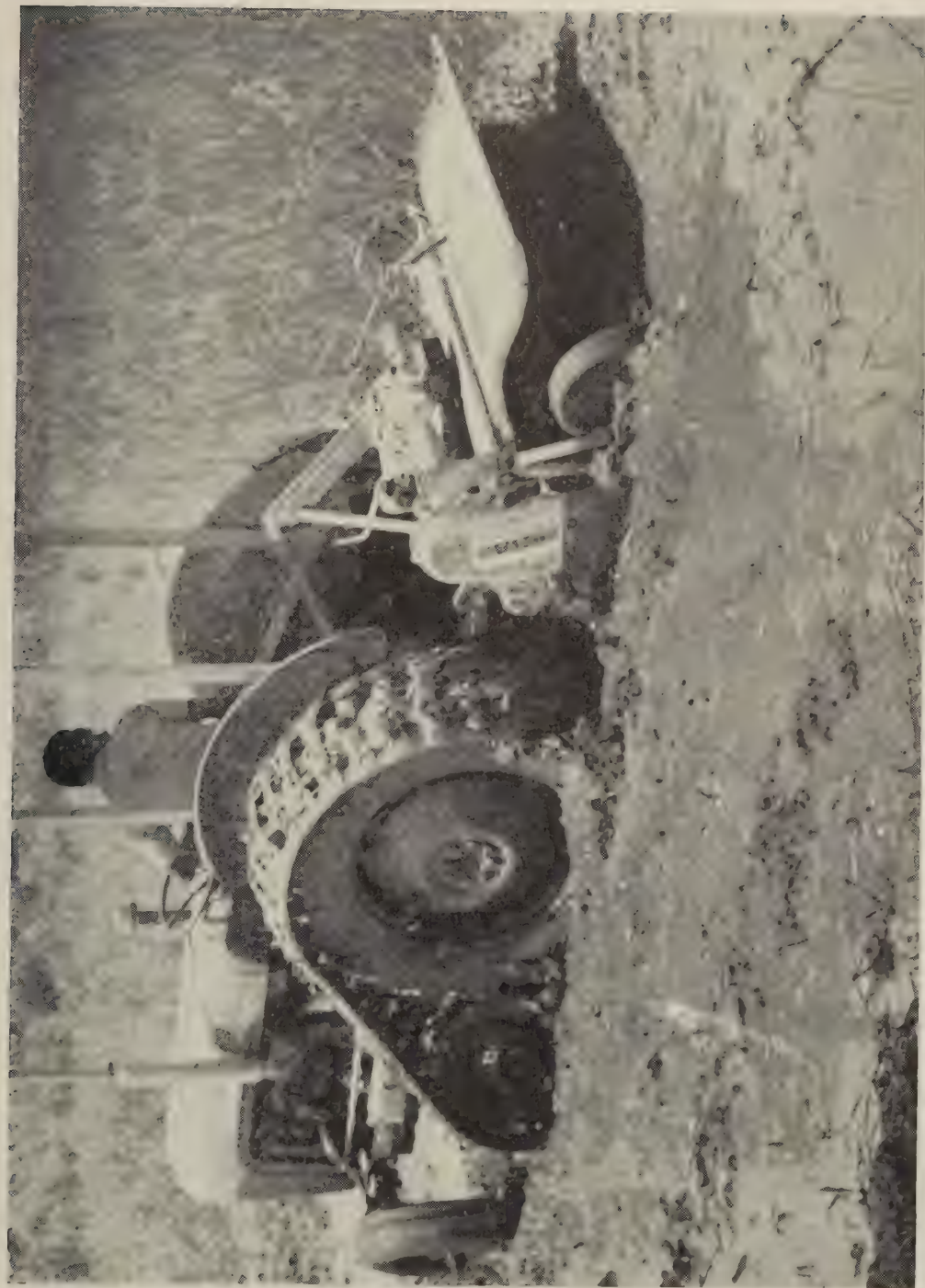
Results.—The chlorinated hydrocarbon insecticides especially Dieldrin 20 per cent E.C. at 5.5 lb per acre, used as foliar spray for the control of these field pests of cowpeas, when properly timed, appear to control *Maruca* satisfactorily but not *Laspeyresia* which attacks seeds inside the pod. But Dimecron 50 per cent has indicated a high degree of control of both the species.



At the Federal Rice Research Station raised irrigated nursery beds are thinly sown (one oz. per sq. yard) in rows four inches apart, between April and June



This results in healthy rice seedlings which are ready for transplanting at four weeks old



The experimental rice fields, having been deep ploughed in the dry season, receive an application of superphosphate ($1\frac{1}{2}$ cwt per acre) and are then irrigated and rototilled in the wet immediately before transplanting. This equipment can also be successfully used on mangrove swamps. An experienced driver is always necessary



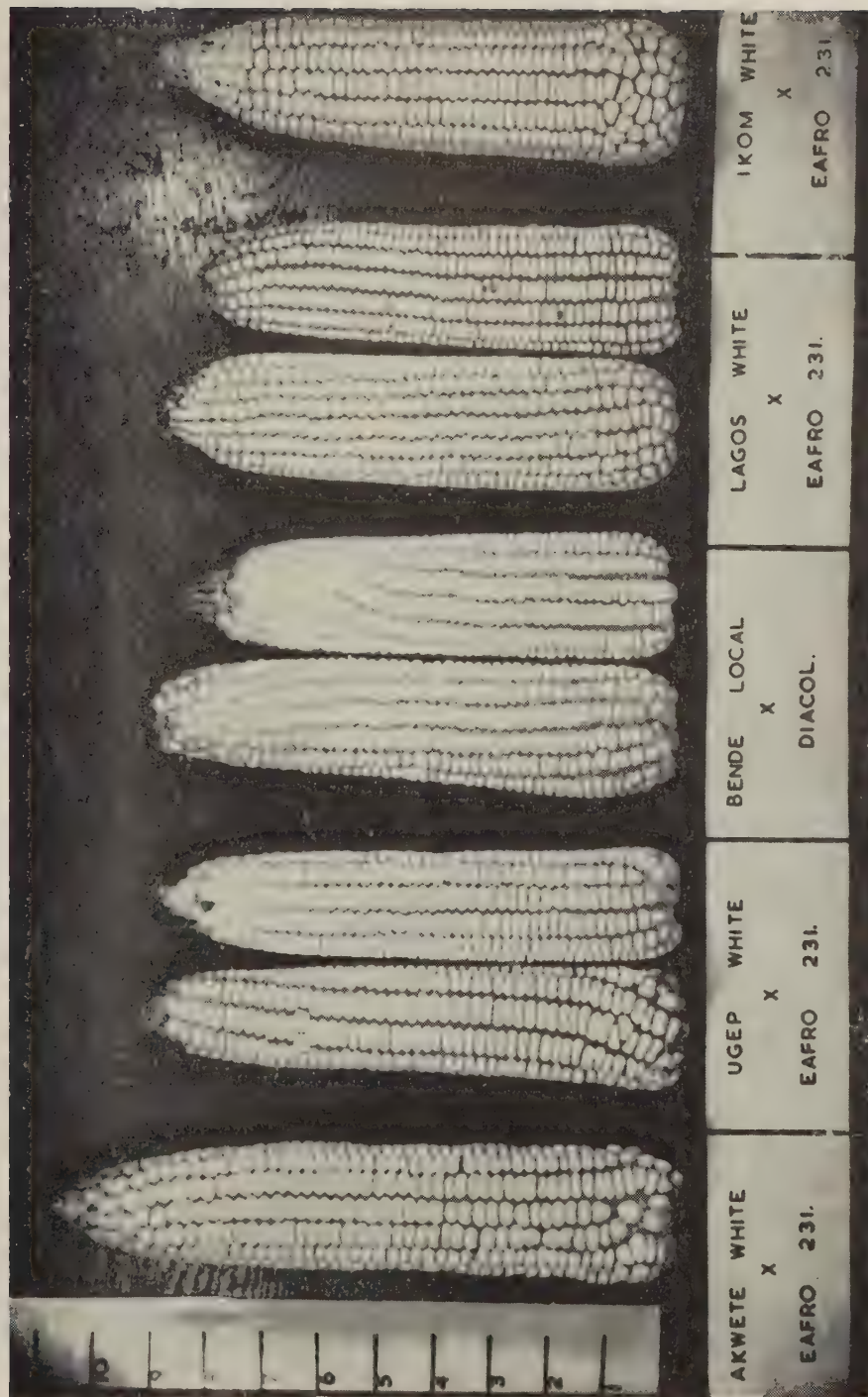
Transplanting takes place in drained fields. The recommended spacing (3 in. apart in rows 12 in. apart) permits subsequent use of the Japanese type rotary weeding hoe. Ammonium sulphate (3 cwt per acre) is applied at 2 weeks and 6 weeks after transplanting



*Timely use of the Japanese type rotary weeding hoe reduces the number of weeding required from three to one
It cost £1 and can be made by the village blacksmith from scrap*



A rice blast disease control trial being sprayed with fungicide



Hybrid ears resulting from crosses between exotic and local varieties of maize



The 'tassels' and 'silk' of selected plants are covered with special paper bags to prevent contamination by foreign pollen



CASSAVA
NATIONAL COLLECTIONS
EXPT. No 6, 1, 4.
FIELD D, PLANTED 3565

The National collection of Cassava varieties includes varieties collected from every part of Nigeria and also, disease resistant material from research centres overseas



Selfing : Pollinator collecting pollen from tassels. The ear of the same plant is pollinated with the pollen

SUGAR-CANE PESTS

The study of insect pest of sugar-cane continued at the sub-station at Bacita. The number of dead hearts on young sugar-cane due to stem-borer and Dynastid beetles increased steadily from May to June. Investigations on the biology and ecology of the Dynastid beetles continued. Two species—*Heteronychus licas* and *Heteronychus oryzae* have been identified. It has been established that two nocturnal flight periods of *H. licas* occur annually—a post-teneral flight—April to July and a pre-reproductive flight—October to December, the peak period of flying beetles being during the first 3 weeks of November. Observations on laboratory cultures at Bacita and Ibadan showed that copulation and oviposition started in October and November respectively and in the field beetle larvae were first observed in October. The observed increase in the number of attacked tillers from October to December was found to be due to the activities of both larvae and adults while the increased number of dead hearts during May and June is caused by adults only since by this time, the larvae stage is over. The abundance and extent of the damage caused by *H. oryzae* have not been properly assessed.

Four species of soil dwelling Carabid predator on *Heteronychus* spp. have been recorded at Bacita. These have been identified as *Scarites tenebricosus* Dej., *Siagona* sp. and *Pheropsophus* sp. The fourth is still unidentified. The adults of *Scarites* sp. feed on *Heteronychus* larvae in the soil.

On stem borers, it is noticed that their population increased greatly during May and June and that *Sesamia* spp. continued to be the dominant species with *Eldana* coming next. *Chilo—Chilotraea* and *Coniesta* spp. were virtually absent during April to June. During the later part of the year October-December the incidence and population of these stem borers decreased considerably probably due to environmental factors and the state of maturity of the crop. As previously recorded, stem-borers lay their eggs on the leaves and the larvae bore into the stem of young sugar-cane plants causing dead hearts.

A number of parasites on the stem-borer species has been recorded. So far, a total of 3 dipterous and 17 hymenopterous parasites and hyperparasites have been recorded.

With the predators and this array of parasites living side by side with these sugar-cane pests there is a strong indication of natural biological control of the pest taking place. The exact mechanism of this is awaiting further investigation.

SWEET POTATO WEEVIL

A study of the biology and control of sweet potato weevil—*Cylas puncticollis*, Boh., was made. This weevil has been recognised as the chief factor discouraging intensive cultivation of sweet potato owing to the severity of attack by both larvae and adults. They burrow into the vines and causing extensive destruction of tissue and inducing putrefaction. Investigations into the biology of the weevil were made at Moor Plantation, Ibadan. It was observed in laboratory cultures that their eggs are laid singly in small cavities eaten into the stem or on exposed tubers. They hatch in about 4-6 days. The larval and pupal stages last for 14-20 days and 5-6 days respectively. The adults emerging from the pupae either remain in the tubers or eat their way out. They are not good flyers and spread to new fields is believed to be usually by means of infested slips or tubers.

Control Experiments.—An insecticidal trial was carried out at Ibadan in collaboration with the Senior Specialist Officer (Root Crop) Mr A. W. Waitt. The following insecticides were applied at 61 days and 120 days after planting: Rogor '40', Telodrin and Dieldrin. Telodrin 0.5 per cent dust was also applied to planting holes at planting as a separate treatment.

Results.—The attack rate on sweet potato tubers in the insecticidal trial was so low that the effect of the different insecticides applied could not be assessed. As it appears that the attack rate by this species varies from year to year and probably from site to site, we hope to repeat the experiment this year.

SOIL FAUNA

A survey of the Arthropod fauna of soils with the aim of obtaining some quantitative and qualitative information about the Arthropods inhabiting the soils of Moor Plantation, Ibadan ; in relation to soil types, crops and pastures, was started in Mid-July and continued up to the middle of October 1963.

Soil samples comprising of a cubic foot of soil, were taken from fields under different types of cover ranging from grass to tree crops. In each sample soils from 0-3 inches, 3-6 inches and 6-12 inches were taken up and examined separately to determine the distribution of the Arthropods in relation to soil depth.

In the laboratory the fauna was separated from the soil by flotation in water and sieving with a number of graded sieves.

It was found that the highest population (77.18 per cent) inhabited the top six inches of the soil and many species were confined to the surface layers.

Apart from termites which have a patchy distribution, the Formicoidea (Ants) formed a very conspicuous part of the fauna. The latter was seen in all the samples and sometimes in large numbers. Other cosmopolitan orders include the Diplura (Japyx), Diplopoda (Millipedes) Chilopoda (Centipedes) and Acarina (Mites and Ticks).

The soil fauna differed to some extent according to the type of vegetation on it both in the number of species and number of individuals present.

FRUIT FLIES (Trypetidae)

An investigation into the biology and systematics of Fruit flies (Trypetidae) was started in December 1963. Comparatively little is known about these important diptera in Nigeria. A wide range of fruits was examined at Moor Plantation and elsewhere and a number of hitherto unrecorded species found. These have been despatched to the British Museum Natural History for identification.

THRIPS and MITES on CITRUS OTHER and ECONOMIC PLANTS

A survey of Thrips (Thysanoptera) and Mites (Acarina) on various economic crops in the locality was begun in December 1963. Collections have been made from many economic plants and ornamentals. Three batches were sent for identification.

ARTHROPODS ASSOCIATED WITH RHIZOBIUM NODULES

An investigation into Arthropods associated with *Rhizobium* nodules of economic legumes was started after reports were received of the occurrence of mites in *Rhizobium* nodules of Cowpeas.

Roots of Cowpeas and Lima beans were taken up and their nodules examined in the laboratory. Mites were occasionally found in open cankerous nematode nodules of these legumes but no association of mites with bacterial nodules was established.

INSECTS ASSOCIATED WITH COCONUT PALMS

Routine examinations of Coconut palm crowns in the vicinity have revealed a wide range of Coleoptera including Curculionids, Cetoniids, Lucanids, Lamiids and Elaterids, also some predaceous Carabids.

CHAPTER VI

REPORT ON THE PLANT PATHOLOGY DIVISION

PLANT DISEASE SURVEY

During the year the following major diseases of crop plants were recorded for the first time in Nigeria.

Castor bean

Grey mould (*Botrytis cinerea* stage of *Sclerotinia ricini*) was widespread in a collection of varieties being grown at Moor Plantation by the Ministry of Agriculture, Western Nigeria; leaves as well as inflorescences were attacked.

Tobacco

Bacterial wilt caused by *Pseudomonas solanacearum* (see bacteriology report).

Wheat

The crop at Hadeijia, Northern Nigeria, was severely attacked by stem rust, *Puccinia graminis* and up to 70 per cent loss in yield was recorded in April.

MYCOLOGY

Rice

Studies have been made on rice blast disease caused by *Pyricularia*. A field trial was carried out on 91 varieties of rice from the Federal collection to determine the resistance of young plants. Thirty-two days after sowing blast disease has developed heavily over the whole trial area and many varieties were killed to the ground. Ratings of resistance were made according to the recommendations of the International Rice Commission of the FAO. Tjina was the only variety rated as highly resistant; Seri Raja was resistant, and the following were moderately resistant (in order of decreasing resistance):—Patnai, Mas 2401, Toma 112, D114, Lead 35, BG 79 and Kav 12. The variety Agbede, the main upland rice variety in Nigeria, was rated as susceptible.

Preliminary work has been done on comparative studies on *Pyricularia* on other hosts and the fungus has been examined in culture from maize, *Eleusine indica*, *Panicum maximum* and *Pennisetum purpureum* which are commonly infected at Ibadan.

Observations on rice plants grown during the year showed a decrease in blast disease during the dry season and a build-up of narrow brown leafspot, *Cercospora oryzae*

Maize.

The resistance of the newly introduced variety Diacol to infection by *Cochliobolus heterotrophus* (*Helminthosporium maydis*) was compared with that of Lagos White in greenhouse experiments. Both varieties were found to be moderately susceptible.

A chlorotic leaf-blotch condition which was widespread on Moor Plantation was investigated but the cause could not be determined.

Cowpea

Two trials to estimate the losses caused by fungus infection were carried out using copper oxychloride and ziram sprays. In both experiments there was no significant difference in yields and the level of disease in the field as a whole was very low. It is proposed to repeat the disease-assay experiment from time to time in order to keep a check on the importance of fungus diseases of cowpeas. Webblight (*Rhizoctonia microsclerotia*) and various leafspot disease including *Cercospora* species and *Corynespora* are sometimes very conspicuous in the field but it is not certain that they have a significant effect on yield.

The use of copper oxychloride apparently had a considerable effect on the vigour of plants and retention of foliage. There was very little defoliation at harvest on the copper-sprayed plots, while those sprayed with ziram were as heavily defoliated as the controls.

A trial to investigate the effect of chemical treatment at planting time on seedling infection by soil-borne *Rhizoctonia* was carried out. Due to the low inoculum potential in the field no difference in disease levels was found between the treated plots (dressing of seeds with mercurial dust and spraying of seed-rows with nabam) and the controls. The use in future of non-rotational land where disease intensity can be increased will be essential for further work on chemical control of the soil-borne fungus diseases of cowpeas.

In the course of the experiments tip-rotting of primary leaves caused by *Fusarium* sp. was observed. Leaf-blotches on older plants was caused by *Botryodiplodia theobromae* and leaf infection by *Sclerotium rolfsii* was also noticed.

Water Yam

Plants in the collection plots at Ibadan were heavily attacked by *Glomerella cingulata* causing anthracnose disease. No varieties showed any resistance and several were killed to ground level.

Sunn Hemp

A disease of *Crotalaria juncea* caused by a species of *Botryodiplodia* killed a large number of plants at the Rice Research Station, Badeggi. Infection occurred on leaves and stems. No control measures seem practicable.

Cacao

White root disease caused by *Fomes lignosus* was examined on young plants in an experimental plot at the West African Cocoa Research Institute's sub-station at Gambari. Several plants were killed by the fungus which is not frequently recorded on cacao. It was last reported attacking cacao at Gambari in 1947.

VIROLOGY

Cowpeas Mottle Virus

Purification of the virus was carried out using various methods and the most satisfactory proved to be extraction in a butanol/chloroform mixture followed by three cycles of differential centrifugation.

Antiserum (kindly supplied by Dr A. J. Gibbs, Rothamsted experimental Station) had a precipitation titre of 1/96 against infective clarified sap.

Cowpea Yellow Mosaic Virus

The primary leaves of plants of different varieties of cowpea when inoculated with either the original or Igporin isolates gave either no reaction or developed necrotic or chlorotic lesions. These three types of reaction were directly related respectively to immunity from, resistance to and susceptibility to infection. A few local pureline selections have been shown to be either immune from or resistant to infection by the virus.

Seven American cowpea varieties differed in their reaction to inoculation with the two isolates; they were immuned from infection by the original isolate but developed necrotic lesions when inoculated with the Igporin isolate. These varieties are therefore useful in differentiating between the isolates, and using them as test plants it was shown that infection of New Era by the original isolate did not give complete protection against infection by the Igporin isolate.

Seed-borne Viruses of Cowpea

Further studies have been carried out on the host range, properties *in vitro* and transmission of the seed-borne virus reported last year. The only additions to the host range were *Lupinus albus* (systemic infection) and *Cyamopsis psoraloides* (necrotic local lesions). Two French bean varieties, Kentucky Wonder and Early Blue Lake, gave necrotic lesions when inoculated with the virus but only a few lesions were produced and neither of these hosts were suitable for assay work.

In a reappraisal of the properties *in vitro* using clarified sap extracted from newly expanded trifoliate leaves, the virus was infective when diluted 1/100 with water but not 1/200; when heated for 10 minutes at 50°C; but not 55°C and after 48 hours at 20°C; but not 72 hours.

Percentage seed transmission varying from 4 per cent to 25 per cent was observed in three varieties of cowpea. The virus was also seed-borne in *Vigna cygindrica* but not in *Phaseolus lathyroides*.

It was not transmitted by either *Aphis craccivora* or *A. gossypii*.

In October 1962, another seed-borne virus was isolated from plants of Paraguay 6 grown in a screened greenhouse. A faint diffuse mottle was observed on the first trifoliate leaves and the later developing leaves showed a light green mottle with distortion. As the leaves became older, the light green areas banded the midribs and the main veins producing an irregular pattern. The virus was transmitted by sap-inoculation to cowpea, *Stizolobium deeringianum* and *Voandzeia subterranea* and through 9 per cent and 3 per cent respectively of the seed collected from infected plants of Paraguay 6 and New Era.

BACTERIOLOGY

Cowpea

Bacterial blight was observed on the early crop at Moor Plantation and a species of *Xanthomonas* was isolated. Attempts at inoculation of New Era and a local white-seeded variety either by spraying or rubbing the leaves with a suspension of bacteria were not successful.

The disease was not serious in local farms but was more common under mono-cropping.

Tobacco

Wilted plants brought in by the Nigerian Tobacco Company from Ago Are, Oyo Province, in June were found to be infected by *Pseudomonas solanacearum*. This was the first recorded occurrence of tobacco bacterial wilt in Nigeria.

Various inoculation techniques were tried out in the laboratory and root inoculation and stem inoculation by pinprick were found to be satisfactory. Wilt symptoms appeared within 8 to 10 days.

The organism was found to lose its pathogenicity rapidly in culture but storage under mineral oil has been found to be effective for maintaining cultures. Kelman's tetrazolium medium has been successfully used as a means of differentiating between pathogenic isolates and non-pathogenic mutants.

The bacterium has been successfully inoculated into *Solanum melongena* and *S. macrocarpon*; tomato and *S. nudiflorum* are resistant to infection.

Sugar cane

A species of *Hanthomonas* was isolated from plants with symptoms suspected to be of red stripe disease, sent in by the Nigerian Sugar Company, Bacita, in September.

CHAPTER VII

REPORT ON THE RICE RESEARCH UNIT

PLANT BREEDING

Four distinct ecological zones are used for the growing of rice in Nigeria, these are naturally inundated Lowlands, the non-inundated irrigable lowlands, the rainfed uplands, and the fresh water mangrove swamps.

It is not possible to obtain a single rice variety with a sufficiently wide range of adaptation to cover all the major zones of rice growing in Nigeria. These zones integrate with one another and in the marginal areas a variety typical of one zone may have a sufficiently wide range of adaptation to be superior to varieties from the neighbouring zone; but where the ecological conditions are clearly defined it is unlikely that varieties adapted to one environment can complete successfully in another. Indeed, it has been shown in the shallow swamp rice improvement programme that if the major zone, the non-inundated irrigable lowlands, is further subdivided it is possible to select varieties for specific areas within the zone. For this reason the plant improvement programme is divided and related to individual zones. In 1963, work on the selection of floating varieties for the naturally inundated lowlands was continued by Mr J. E. Y. Hardcastle and Mr B. D. A. Beck. Mr Sluyters and Mr Patil worked on the production of varieties for the non-inundated irrigable lowlands and Mr Beck on the programme for the rainfed uplands and the interspecies hybridisation work.

Work commenced on preparing an experimental site in the mangrove swamps on Egbe Island, Warri to enable a programme of research on this zone to commence in 1964.

The Naturally Inundated Lowlands

Many of the river valleys of Nigeria, particularly those in the Far North are subject to seasonal deep flooding. The rice varieties traditionally grown in these areas are red grained cultivars of the indigenous species *Oryza glaberrima*. They are well adapted to the duration of the floods, able to withstand flood flow and show a floating habit in deep water. Red grain has only local appeal and the removal of the red pericarp during milling is not easy. This character restricts the markets available for the crop, and if rice production is to expand and become profitable in these areas it is necessary for the farmer to grow a white grained variety. The object of the improvement programme for these areas is to select high yielding white grained floating varieties of *Oryza sativa* with a vigour and flood resistance comparable with the indigenous *O. glaberrima*.

Regional Variety Trials.—In the Birnin Kebbi area the *O. sativa* variety Mali Ong has been recommended and has proved a great success ; farmers are rapidly changing over to this new variety. In 1964, 45,000 lbs. of seed has been distributed through the Northern Ministry's multiplication scheme to farmers who did not receive seed last year.

In observation plots in the Jere Bowl Mali Ong and the local *O. glaberrima* variety Babban Fari, gave yields equivalent to 3,100 lbs per acre. Mali Ong was severely contaminated with volunteer plants of *O. glaberrima* and if this variety is to be grown in the Jere Bowl it is essential that the preliminary cultivations are so timed to eradicate *O. glaberrima*.

At Illushi, Mali Ong was compared with the shorter duration variety Indo Chine Blanc. The highest yields were obtained from Mali Ong when planted in May (3,100 lbs per acre) and from Indo Chine Blanc when planted in April (3,040 lbs per acre). The yields from later plantings declined sharply, for example Mali Ong gave only 622 lbs per acre when planted in July, while yields of Indo Chine Blanc fell even further to 280 lbs per acre.

Variety Trials, Badeggi.—Earlier trials have shown that some *O. glaberrima* varieties have a very high yield potential and two selected lines were compared with Mali Ong and five short duration *O. sativa* floating lines. There was no significant difference between the yields of Mali Ong and the *O. glaberrima* variety Dan Boto. The yields of these varieties were very high, 5,000 lbs per acre, and were very highly significantly greater than those of any other variety in trial.

A breeding programme to produce short duration varieties was commenced at Badeggi in 1960. The variety Indo Chine Blanc was used as the early parent and crossed with three high yielding long duration varieties. 105 F₃ progeny from these three crosses were grown in 1963. There were significant differences between progeny yields. Ninety-six individual plant selections for earliness were made and both the highest yielding bulk progeny and the individual plant selections were retained for further trial in 1964. The F₂ generation of a further series of three crosses was grown and twenty-two individual plant selections were made. One of the parents in these crosses was a very high yielding but red grained variety of *O. sativa*. Segregation for grain colour was observed in the F₂ generation and will be further examined in the F₃.

The Non-Inundated Irrigable Lowlands

The most widely grown variety in the non-inundated irrigable lowlands is BG 79, originally introduced from British Guiana. This variety, more than any others has been responsible for establishing the present day preference for long grain rice. It owes its wide distribution to its high yield potential and great range of environmental tolerance. In rice growing areas where the environmental conditions are relatively clearly defined it has now been possible to replace BG 79 by higher yielding varieties. MAS 2401 is now recommended to replace BG 79 in areas where irrigation water is available for 5½ months. D 114 is now the recommended variety at Zonkwa and D 99 at Shendam. These varieties, in addition to BG 79, were distributed through the Multiplication Scheme for the first time in 1963.

Hybridisation and plant introduction programmes were continued to produce new BG 79 replacements, for example in rain-fed swamps, water is frequently not available for a long enough period to allow BG 79 to develop its full yield potential and new varieties of around four months duration are being developed. Breeding programmes to develop saline resistant varieties were continued.

Variety Trials : Badeggi.—In areas where irrigation water is available for five months the former standard variety BG 79 has now been replaced by the variety MAS 2401. Six new varieties selected from the variety collection were compared with BG 79 and MAS 2401 at

Badeggi in 1963. MAS 2401 was the highest yielding variety in trial, with a yield equivalent to 2,750 lbs per acre. As in 1962 there were no significant differences between the yields of MAS 2401, E.I., Dissi N14 and SC 308/51. Milling tests were carried out on these varieties; E.I., and the low yielding shingo la Mjane, had poor milling quality and gave a sticky product when cooked. The quality of the other varieties was satisfactory.

In a trial of eight varieties of six months duration the highest yielding variety was Gambiaka Sebela (4,400 lbs/acre). There was no significant difference between the yield of this variety and Siam 29. The life period of Gambiaka Sebela is twenty days shorter than Siam 29. Gambiaka Sebela produced a significantly greater yield than the other varieties in trial.

The trial of varieties of seven months duration, aimed at finding a high yielding replacement for the standard variety KAV.12 was continued for its final year. In 1963, Seri Raja gave a significantly greater yield than any other variety in trial. In a joint analysis of three years results, Khao Bhu Dat was the highest yielding variety, although its yield was not significantly greater than KAV.12. There is, at present, no replacement for KAV.12 and as the current demand for varieties of seven months duration is small this trial will not be repeated.

Regional Variety Trials.—Rice cultivation is developing in Plateau Province and special varieties are required which are adapted to the cooler conditions. The variety Sindano, introduced from Kenya in 1963, gave yields of 4,000 lbs per acre. Rojofotsy gave yields equivalent to 2,800 lbs per acre when direct seeded.

Observation plots were continued at Dass where the highest yielding varieties were BG 79, ADT-4 and Makalioka 823. BG 79 was the highest yielding variety in observation plots at Jere Bowl. An analysis of three years data from Jere Bowl indicated that there are no significant differences between the yields of BG 79, D114 and Makalioka 823 and these will be compared in replicated farmers plots in 1964.

Four short duration varieties were compared with BG 79 on the saline-alkaline soils at Yau in Bornu Province. As in 1962, Tai Chu 65 was the highest yielding variety. In trials of longer duration varieties at Yau the varieties D 99, LEAD 35 and HMA-9 were outstanding. This was the first time they had been tested at Yau and they will be included in a formal trial in 1964.

In the trial at Pategi, to select a suitable variety for a late crop after the main crop has been harvested, four short duration varieties were compared with BG 79. As in 1962 there were no significant differences between the yields of BG 79 and the short duration varieties Precose, CO-13 and MTU-9. All these four gave a highly significantly greater yield than CO-9. BG 79 is the standard main crop variety and it would appear that it should be also grown as the late crop. This has the added advantage that only variety is required for the multiplication scheme in this area and the long grain type of BG 79 is clearly preferred to the bolder grain of the short duration varieties.

Observation plots of three varieties were planted at Ago Amodu to determine the variety most suited to the rainfed swamps of the area. Water was available throughout the experiment but yields were low, around 300 lbs/acre. New varieties will be introduced into this area for further trial in 1964.

In a variety trial at Abakaliki, five varieties were compared with BG 79 in a 6×6 Latin Square. The irrigation facilities for the trial were poorly maintained and it was severely attacked by nematodes. MAS 2401 was the highest yielding variety.

Intraspecies Hybridisation.—In a breeding programme to produce stiff strawed, lodging resistant varieties 561 F₅ pure line selections from Crosses 1, 2 and 3 were planted in the field. Growth was good and the progeny were reasonably uniform in this generation. Sixty of the

original pure lines were retained. Two hundred and eighty new individual plant selections were made from these crosses in the field, of which seventy-four were retained after panicle analysis in the laboratory.

Cross 27 was designed to produce short duration BG 79 replacements. Two hundred and seventy-seven individual plant selections were sown on the fadama at Badeggi. One hundred and twelve were discarded as highly susceptible to *Pyricularia*. Thirty-four high yielding pure line selections were retained for further trial. One hundred and sixty-three selections from this cross were planted on a farmers' field to examine the effects of selection under different environmental conditions. Fifty-seven individual plant selections were made. An F_3 bulk population from this Cross was also grown at the Jere Bowl to further examine the environmental selection effects. Two hundred and forty-seven selections were made from this bulk population for further testing in 1964.

Bulk F_3 populations of a further five crosses between BG 79 and short duration varieties were grown at Badeggi. Some 4,800 individual plant selections were made in the field from these bulk populations, of which 431 were retained to be grown as individual plant progeny in 1964.

Bulk F_3 populations of two Crosses between G.E.B. 24/37 and early varieties were also grown at Badeggi. Two thousand one hundred and twenty-three individual plant selections were made in the field, of which 139 were retained for further trial after panicle analysis in the laboratory.

It is proposed to grow short duration varieties of rice in rotation with wheat in the Yau irrigation scheme. The soils in this area are alkaline saline in reaction and in earlier trials the varieties PTB-16, MTU-9 and Tai Chu 65 have proved able to yield well under these conditions. They are, however, of too long duration to fit into the rotation and a hybridisation programme between these varieties to produce saline resistant, short duration varieties was commenced at Badeggi in 1963. The F_1 and F_2 generations have been grown in pots and the F_3 will be grown at Badeggi in 1964. Bulk F_4 populations will undergo selection at Yau.

The Variety Collection.—Recommended rice varieties from other countries are introduced to Nigeria through the Plant Quarantine Service to the Rice Research Station, where they are tested in the Variety Collection. The new varieties are classified according to their habit and length of life period. They are compared, under shallow swamp conditions, with a control variety of the same life period. Early maturing varieties with a duration of 90 to 130 days are compared with MTU-9 as a replicated control. Medium duration varieties with life periods of 131 to 180 days are compared with BG 79 and long duration varieties of 181 to 240 days are with KAV.12. The duration, habit, pigmentation, sterility and yield of the introduced varieties are noted and compared with the control.

In 1963, 412 introduced varieties were compared with the three replicated controls. One hundred and twelve varieties of swamp rice were selected for further trial in 1964. Seed of the other varieties will be retained at low temperature as this collection also provides a 'gene bank' for the plant breeder. The viability of this seed will be tested at two-year intervals and if it declines significantly the stock will be renewed in a maintenance collection.

The Rainfed Uplands

Many traditionally grown Nigerian upland varieties have a D-type glutinous grain. It was shown in preference tests carried out in Western Nigeria in 1963 that the long grained rice varieties are clearly preferred and the increasing demand for B-type grain, noted in the 1962 Annual Report was confirmed. The leaf fungi, *Pyricularia oryzae* and *Helminthosporium oryzae*, are widespread in the areas of upland rice growing and cause severe losses to the crop. The objects of the improvement programme with upland rice are to produce high yielding varieties with a B-type grain and high resistance to *Pyricularia* and *Helminthosporium*.

Regional Variety Trials.—The 1962 series of variety trials were continued in Western and Mid-Western Nigeria. The trials were replicated at seven centres and contained four Nigerian varieties and two varieties from Ceylon. Earlier trials at Badeggi and Irrua indicated that the Singalese varieties were of very high yield potential, but in the 1962 trials they were severely attacked by *Pyricularia*. In 1963, the attack of *Pyricularia* and *Helminthosporium* was severe on all trials. It was noted that the life periods of the introduced varieties Suduwee and VI 28061 were significantly longer than those of the indigenous lines. It appeared that the time of attack by *Pyricularia* was of considerable importance; the longer duration varieties were less mature when the disease became widespread and suffered severe vegetative damage at this stage. The Nigerian variety Jete was significantly higher yielding than any other variety at Irrua, Obior, Ofada, Erin Oke, Ikole and Igbemo. At Ipokia, the attack of *Pyricularia* was less severe than in the other trials and in this trial there were no significant differences between the yields of Jete and the two introduced varieties. The error variances of these trials were heterogeneous and in a weighted joint analysis of the trials, Jete gave a very highly significantly greater yield than any other variety. There was no significant difference between the yields of Agbede 140/54 and Agbede 16/56. There were significant differences between the yields at individual trial sites. The highest average yields were obtained at Irrua. The highest yields, that of the variety Jete, was recorded at Erin Oke and was equivalent to 2,430 lbs per acre.

The results of these trials confirmed those obtained in 1962. Jete is the highest yielding upland variety currently available, but it is not generally popular as it has a D-type grain. The long grained variety Agbede 16/56 is now the recommended upland variety in Western Nigeria and the short grained Agbede 140/54 has been discarded from the Multiplication Scheme. It is obvious that upland rice is a crop with considerable yield potential in these areas and that one of the major limiting factors to high levels of production is disease attack. The trials will not be continued until new *Pyricularia* resistant lines are available.

A trial of thirteen upland varieties was replicated at Jema'a, Badeggi and Moor Plantation to compare the yields of these varieties in three markedly different environments. There were no significant differences between variety yields at Jema'a, VI 28061 was the highest yielding variety. At Badeggi, VI 28061 gave a highly significantly greater yield than any other variety. The Moor Plantation trial was severely attacked by rodents and birds and it was not possible to analyse it, nor was it possible to conduct on joint analysis of these trials and they will be repeated in 1964.

A collection of forty upland varieties were compared with replicated controls at three centres. No one variety was outstanding at all the centres, but the most promising group of varieties were those imported from the Congo. There were of short duration, showed high resistance to *Pyricularia* and were in general considerably higher yielding than the control variety Agbede 16/56. At Moor Plantation the varieties imported from Ceylon were of too long duration and failed to produce a crop. At Ofada and Irrua, where the rains continued for a longer time, these varieties were able to mature but proved susceptible to *Pyricularia* particularly as leaf blast in the early stages of growth.

Variety Trials : Badeggi.—To compare the results obtained from trials in the West with those from Badeggi, the six variety trial described above was also replicated at Badeggi. It was not included in the joint analysis of the trials as the results obtained were, as in 1962, completely different from those from the West. VI 28061 gave a very highly significantly greater yield than any other variety. Suduwee also gave a very highly significantly greater yield than the four Nigerian varieties. This is a complete reversal of the results obtained in the West and may be accounted for by the low incidence of *Pyricularia* and *Helminthosporium* at Badeggi. The testing of upland varieties at Badeggi will continue; the conditions on the fadama permit the expression of maximum yield potential and this is of value in selecting high yielding parents for the breeding programme.

Three selections from the variety Agbede 140/54 were compared with bulk Stage I material at Badeggi. As in 1962, no significant differences between the yields of the selections and the bulk material were noted and the trial will not be continued. Eight selections from Agbede 16/56 were compared with bulk State I material at Badeggi. As in 1962, the differences between the yield of the selections were not significant.

The variety Jete has long awns which make it unpopular with the millers. Occasional short awned or awnless plants occur and the selection of both awned and awnless lines commenced in 1962. Yields from the selected progeny in 1963 were disappointing, but they continued to breed true for the expression of the character Awn. They will be multiplied in 1964 for trial.

During 1963, varieties were tested for resistance to *Pyricularia*, in field nurseries and in greenhouse inoculation trials. In both series of experiments the variety Tjina has shown a very high degree of resistance to infection and will be used in a breeding programme for *Pyricularia* resistant lines. In a trial to investigate the yield losses in upland rice caused by *Pyricularia* by controlling the disease with fungicides, the fungicides Blasticidin (benzyl amino benzene sulphonate and phenyl mercury acetate) and Thiocupfer (copper oxychloride and sulphur) were applied as a spray to Agbede 16/56 and compared with untreated controls. The incidence of *Pyricularia* on this trial was low until the heading stage. The severity of infection, as measured by the number of lesions on the flag leaf, was significantly reduced by both fungicides when compared with an untreated control. Blasticidin was rather more effective than Thiocupfer, but the difference was not large enough to be significant. A combined spray of Blasticidin and Thiocupfer was significantly more effective than Thiocupfer alone. The attack of *Pyricularia* came too late to markedly effect yields and no significant differences between treatments were demonstrated, but the yield from plots receiving the combined treatment was 39 per cent higher than the untreated control. The experiment will be repeated.

Interspecies Hybridisation.—The species *Oryza glaberrima* is indigenous to West Africa and inhabits a wide range of environments. It has marked vegetative vigour. The Nigerian varieties of this species have two disadvantages as cultivars, they are red grained and they shatter when ripe. A breeding programme to combine the vigour of *O. glaberrima* with the white grain character and non-shattering habit of *O. sativa* was commenced in 1958 when the two species were successfully crossed together.

The F₅ generation of Cross 14 and the F₃ generations of Crosses 20 and 29 were grown in 1963. They were harvested early in 1964 and a full analysis of sterility and yield in these progeny has not been completed. Segregation for grain colour was noted in some lines.

AGRONOMY : SHALLOW SWAMP RICE

Plant Population Trials

The first series of plant population trials led, in 1964, to the recommendation of a new spacing of 36 square inches per plant, in rows 12 inches apart with plants 3 inches apart in the row. It was considered necessary to further investigate the influence of the shape and size of the unit area per plant on development and yield, using a wider range of spacings than had been previously employed. In 1963, unit areas of 144, 100, 64, 36 and 16 square inches per plant were investigated. For each area two shapes were compared; square areas with sides in the ratio of 2 : 2 and oblong areas with sides in the ratio of 1 : 4. The experimental error of this trial was high and significant differences could not be demonstrated, but the plants in oblong areas gave consistently higher yields than plants in square areas, save at the 16 square inches per plant spacing.

A trial to investigate the interaction of fertilizer treatment and plant density failed and both this trial and the one above will be repeated in 1964.

Trials to investigate the interaction of seed rate and spacing in direct seeded rice were planted at Shendam and Jere Bowl. The seed rates were 30, 60 and 90 lbs per acre, in all combinations with spacings of 6×6 inches, 12×12 inches, 18×18 inches and a broadcast treatment. At Shendam there was a significant interaction between the linear spacing and linear seed rates. Increased seed rates linearly decreased the effect of spacing; the highest yields at 90 lbs per acre were obtained at a spacing of 18×18 inches and the highest yield at 30 lbs per acre obtained at 6×6 inches. The trial will be repeated in 1964. In Jere Bowl, a highly significant response to the spacing treatments was obtained. The highest yield was obtained from the 6×6 inches spacing treatment which gave 3,125 lbs per acre, 734 lbs more than that from the traditional broadcast method. In this trial, seed rate had no significant effect on final yield.

Nursery Technique Trials

Data from nursery technique trials carried out at Badeggi in 1958 and 1960 indicated that plants which were transplanted after 4 weeks in the nursery gave a significantly greater yield than plants which were eight weeks old at transplanting. This result was reversed in 1959, but in that year the nurseries were sown some six weeks later than in 1958 and 1960. Therefore, a new trial was designed, to study the interaction of sowing date, the length of time seedlings are grown in the nursery and the effect of applications of sulphate of ammonia on the optimum length of nursery period for the variety BG 79. Three sowing dates, separated by eight-week intervals with nursery periods of four, six and eight weeks and applications of sulphate of ammonia at 0, $2\frac{1}{2}$ and 5 cwts per acre were compared in a 3^3 factorial design. There were no significant differences in the yields of seedlings in the first sowing in May; seedlings transplanted at six weeks gave the highest yield. With the second sowing, in July, there were no significant differences between the yields of seedlings transplanted at four and six weeks old, but those transplanted at eight weeks gave a significantly lower yield. Seedlings transplanted at four weeks old in the third sowing, in September gave the highest yield. The yield of seedlings transplanted after four weeks in July was significantly less than the yield of four-week old seedlings transplanted in May, but the September sowing gave a significantly greater yield. The application of sulphate of ammonia influenced the colour, height and vigour of the seedlings in the nursery, but had no significant effect upon the final yield.

In a second experiment to compare the interaction between two nursery periods, three sowing dates and four varieties, BG 79, MAS 2401, D 99 and D 114 were compared in all combinations in a $4 \times 3 \times 2$ factorial experiment. Seedlings of BG 79 transplanted when four weeks old gave a consistently greater yield than eight-week old seedlings in all three sowings. Eight-week old seedlings of the variety D 99 gave a significantly greater yield than four-week old seedlings when sown in May, but this result was reversed for later sowings in July and September. There was no significant difference between the yields of four and eight-week old seedlings of the variety D 114 when sown in May, but four-week old seedlings gave a significantly greater yield in the July and September sowings. Both D 99 and D 114 produced their highest yields from seedlings sown in July and transplanted after four weeks in the nursery. MAS 2401 gave significantly greater yields from four-week old seedlings in the May and September sowings.

MAS 2401 is insensitive to photoperiod and when transplanted at four weeks old from September sowings gave a highly significantly greater yield than any other treatment in the trial with a yield equivalent to 4,900 lbs paddy per acre.

Seed Dressing Trials

Trials were planted at Badeggi and Jere Bowl to investigate the effects of fungicide—insecticide seed dressings on the yield of rice. No significant differences in yield were demonstrated at Badeggi, although the highest germination percentage and the greatest yield were obtained from seed treated with Aldrex T. (Thiram + Aldrin). In the Jere Bowl the yield of the replicates was mistakenly bulked at harvest and both experiments will be repeated in 1964.

Crop Rotation Experiments

The selection of leguminous crops able to grow in the dry season on fadama soils without supplementary irrigation was commenced in 1960. The legumes may be used as green manure, cattle food or for human consumption. In a green manuring trial eight legume species were compared with a natural fallow, with *Andropogon gayanus* as a cover crop and with the application of 5,000 lbs of rice straw per acre. All the treatments were split for an application of superphosphate at nil and two cwts per acre. The green manure crop was cut and turned into the soil, which was then flooded for one month before transplanting the rice crop. Marked yield increases were demonstrated in the rice crop especially from a mixture of *Sesbania sericea* and *Calopogonium mucunoides*. There was a positive response to the applications of phosphorus, although not as marked as in the 1962 trial ; as before the response was most marked on the natural fallow crop.

It is considered that phosphorus is important in the development of the root system of these fallow crops and further work is being carried out on the utilisation of phosphorus under these conditions. Further trials of grain legumes were commenced in 1964.

Fertilizer Trials : Shallow Swamp Rice

A trial to investigate the interaction of Nitrogen and phosphorus applications with seed rate was planted at Shendam. Significant yield increases were demonstrated from applications of two cwts per acre of superphosphate. Yields were low and the absence of a significant response to nitrogen suggest that growth was limited by another factor and potassium applications will be included in the trial in 1964.

In an N×P trial at the Duku Lade Irrigation Scheme the variety MAS 2401 gave very high yields and significant, economic yield responses were demonstrated with applications of up to two cwts sulphate of ammonia per acre. A significant N×P interaction was also demonstrated.

In a trial at Jere Bowl, three rates of application of both sulphate of ammonia and superphosphate with three methods of application of sulphate of ammonia were compared. Significant quadratic yield increases were obtained with applications of sulphate of ammonia which suggest the optimum rate is between two and four cwts per acre. A significant linear yield response was found with applications of superphosphate up to four cwts per acre. There was a significant interaction between N×P. There were no significant responses to the method of application, although the highest yields were obtained when half the sulphate of ammonia was applied before seeding and the second half applied four weeks after seeding.

An N×P 3² factorial experiment was planted in Suriyan in 1962. A marked phosphorus deficiency was noted in that year, which was counteracted by application of one cwt per acre of superphosphate. The N×P quadratic interactions were significant. The same site was used in 1963 to test the residual effects of superphosphate with 3 levels of ammonium sulphate. No residual effect of phosphorus was demonstrated and sulphate of ammonia caused significant decreases in yield.

However, a new N×P experiment at Suriyan in 1963 showed very significant quadratic responses to nitrogen, application of two cwts per acre of sulphate of ammonia raised yields by 47 per cent. The response to nitrogen decreased with increasing phosphorus levels. Chemical analysis of straw samples from this trial suggest that potassium becomes limiting with the high N and P levels and this trial will be modified in 1964 to include a potassium treatment.

Replicated Farmer's Plot Trials

The fertilizer trials carried out between 1958 and 1961 on the alluvial soils of the Niger and Kaduna flood plains led to preliminary recommendations of 3 cwts of sulphate of ammonia and $1\frac{1}{2}$ cwts of superphosphate per acre as the optimum rates of fertilizer application for shallow swamp rice in these areas. At the same time these recommendations were made, the new variety MAS 2401 was selected to replace BG 79 on the irrigation schemes and the optimum plant spacing of 12×3 inches was determined. These three recommendations were tested in a replicated farmer's plot trial in 1963. This trial consisted of sixteen replicates on the Badeggi, Edozighi and Loguma Irrigation Schemes. Each replicate was sited on a soil type which was typical of the locality, and contained five treatments, local planting practice, 12×3 inches spacing with no fertilizer, with $1\frac{1}{2}$ cwts per acre sulphate of ammonia, with 3 cwts per acre of sulphate of ammonia and with 3 cwts per acre of sulphate of ammonia and $1\frac{1}{2}$ cwts per acre of superphosphate. The 12×3 inches planting method gave an eleven per cent increase in yield over the local practice. It was generally observed that while the new method required more labour for transplanting this was easily offset by the reduced amount of weeding necessary in the denser crop. An average linear response of 11 lbs paddy per pound applied nitrogen was found from these trials, which agrees closely with the findings from the earlier fertilizer trials. One and a half hundredweights per acre superphosphate gave a yield increase of eleven per cent over the non-phosphorus treatment, this response was not obtained from the earlier trials. This experiment will be extended in 1964 by doubling the number of replicates in Niger Province and extending the trials to the south bank of the Niger in Ilorin Province.

AGRONOMY : UPLAND RICE

Upland rice is traditionally grown in Western and Mid-Western Nigeria as the first crop after a bush fallow. Thus the crop has the benefit of the fertility accumulated during the fallow period and, as the first crop after the fallow, is relatively free from weeds. The crop is sown in late March or early April either by broadcasting or dibbling at spacings between 10 to 12 inches between stands. A programme of investigation was commenced in 1963 to determine if cultural methods could be improved and if upland rice could be profitably included in the changing pattern of agriculture in which the frequency and duration of bush fallows were decreasing. In all the experiments described below the standard recommended variety Agbede 16/56 was used.

Plant Population Studies

Four spacings and three seed rates (number of seed per hole) were compared in a trial at Moor Plantation. Significant differences were observed between spacings ; a planting distance of 12×12 inches gave the greatest yield, equivalent to 2,710 lbs per acre which was significantly greater than the yields from the currently recommended spacing of 12×6 inches (2,220 lbs/acre). Both the linear and quadratic components of the spacing treatments were highly significant. The yield from plantings with six seed per hole was greater than those obtained from three and nine seed per hole, but the differences were not large enough to be significant.

At heading time, this trial was invaded by rats which caused severe damage by cutting tillers at the base of the plants. The number of damaged tillers was expressed as a percentage of the total number of fertile tillers and it was shown that significantly more damage occurred at the closer spacings, 43 per cent damage at a spacing of 12×3 inches compared with 12.1 per cent damage at 12×12 inches. The rats apparently preferred the closer spacings, which gave them better cover.

Upland rice is traditionally planted on the flat and it is possible to mechanise sowing with the use of a seed drill. Four seed rates, sown in rows 12 inches apart were compared with direct seeding at 12×12 inches and 12×6 inches with six seed per hole. The errors of this trial were high and rat damage was widespread. Again the minimum amount of damage occurred, and the highest yield was obtained, when the plants were spaced at 12×12 inches. This spacing, with six seed per hole requires 15 lbs per acre and there was no significant difference between the yields from spaced plants and rice drilled in 12-inch rows at 15 lbs per acre, but 12×12 inches spacing gave significantly greater yields than rice drilled at 30, 45 and 60 lbs per acre. At Moor Plantation yields were high, the best treatments giving between 2,600 and 2,700 lbs per acre, but if yields are to be further increased the effective control of rodents is essential.

Date of Planting Trials

The duration of Agbede 16/56 is around 130 days and is typical of the locally grown varieties of upland rice. Serial plantings at fortnightly intervals were made at Moor Plantation between 8-3-63 and 12-7-63. The results from this type of trial are greatly influenced by the distribution of rainfall in any given year; in 1963 the highest yields were obtained from sowings in the last week of March or the first week in April. Sowings later than 20-5-63 failed. The trial will be continued in 1964.

Fertilizer Trials

In a trial to determine the effect of time of application of nitrogen, and the interaction with spacing, 200 lbs. per acre of sulphate of ammonia were applied two weeks after sowing or split into equal sub-divisions applied 2 and 6; 2, 6 and 10; and 2, 6, 10 and 14 weeks after sowing. The application of 200 lbs. per acre of sulphate of ammonia split into four equal applications gave a significantly greater yield than when applied as one or two applications. Plants spaced at 12×12 inches gave a significantly higher yield than those spaced at 12×6 inches. The spacing $\times$ time of application interaction was not significant.

A trial to compare the effects of application of 3 levels of sulphate of ammonia, superphosphate and muriate of potash in all combinations and combined with three spacing treatments was planted at Irrua. No significant differences between main treatments were demonstrated. The application of 150 and 300 lbs per acre of ammonium sulphate caused slight decreases in yield and it was noted that *Pyricularia* infection was most severe on the nitrogen treatments. No treatment interactions were significant and the trial will be repeated in 1964.

MILLING STUDIES

In Nigeria, paddy is soaked in water at ambient temperature before parboiling. In a study of the influence of the length of soaking time on the percentage of broken grain in the final milled product, it was shown that the optimum soaking time varied between varieties. The optimum soaking times for the recommended varieties in the multiplication scheme were determined, and varied between eighteen and forty-eight hours. During the soaking of the rice, fermentation by bacteria and yeast commences. Fermentation results in the development of off-flavours during the cooking of the rice. Fermentation can be reduced by soaking the paddy in warm water at 70°C ; at this temperature the recommended varieties

need to be soaked for only four to six hours to produce a good translucent grain in the milled product. The temperature of the water should not rise above 80° C, or many grains are broken during milling.

Mature grain in the field is subjected to diurnal wetting and drying which causes cracks to arise in the grain and these adversely affect milling quality. Trials were conducted to investigate the effect of date of harvest on the frequency of the occurrence of grain cracks. A large increase in the number of cracked grains was noticed in delayed harvests of KAV. 12. However, it was found that after parboiling, the percentage of broken grain after milling was roughly constant and was not affected by the number of cracks initially present in the grain. Parboiling anneals the grain cracks and reduces the amount of breakage during milling.

Studies on the drying of grain after parboiling were continued, it was noted that cracks may appear in the grain if drying is too rapid or too severe. In 1962 it was shown that parboiled paddy could be efficiently dried in the sun at Badeggi at the end of the rainy season (October-November) and that the lowest percentage of broken grain occurred when paddy is dried to, and milled at, a moisture content of 16-17 per cent. These experiments were extended in 1963 and it was shown that if parboiled paddy was dried in the shade, or slowly dried artificially, variations in moisture content of the dried grain of between 13-18 per cent have no effect on the final milling quality. In 1963, investigations on the drying of parboiled paddy during the harmattan season were commenced. Drying conditions varied markedly from day to day and no final figure for the optimum drying time or final moisture percentage could be determined.

Comparative tests of the laboratory mills at the Rice Research Station and a local mill in Badeggi indicated that both give parallel results but that the percentage broken grain in the Badeggi mill is always higher than in the laboratory mill. In a survey of the Bida area it was shown that 33 per cent of the grain was broken during milling in the local mills. Using large samples of rice treated with the recommended hot water soaking time and with careful drying it has been possible to reduce the percentage broken obtained from the local mill to 14.2.

CHAPTER VIII

REPORT ON THE ROOT CROPS RESEARCH UNIT

INTRODUCTION

Since the last annual report, there has been no advance in the building programme nor have the negotiations for land been completed. This latter delay is probably due to the shortage of staff in the Ministry of Lands and to pressure of work put on the remaining staff. The co-operation of the Ministry of Agriculture during this period has been excellent and land has been allocated to the Unit at Umudike and this has permitted the work on rootcrops to continue.

There has been a further reduction in the programme of work due both to a reduction in staff and in funds. The work on Regional Trial Stations has been more affected than at the main centre, Umudike. It has been possible to strengthen the out station teams by posting an Agricultural Assistant to Benin and a Field Overseer to Mokwa to assist the Agricultural Assistant already there.

The selection work for rootcrops in the Mid-West has previously been carried out at W.A.I.F.O.R., Benin and it has now been found expedient to transfer this work to the Rubber Research Station at Iyanomo. The transfer will be completed in July with the cassava planting. The staff of the Unit is very grateful to the Director of W.A.I.F.O.R. for the use of land and facilities which provided the Unit with a suitable selection centre under the environmental conditions of high rainfall and sandy soil.

PLANT BREEDING : YAMS

Varietal Collections

In the collection there is a total of 374 varieties of the three main economic species—white, yellow and water yams, an additional 28 varieties of the cluster yam are also being maintained. It is considered necessary to duplicate much of the yam collection at Ibadan as the wetter conditions, particularly for storage at Umudike do not favour some of the varieties. High loss of tubers in storage have caused the loss of a number of varieties.

A further 87 collections were made this year (Table I) and they will be multiplied for further testing.

Table I.—Yam collections made in 1963

<i>Station</i>						<i>Species</i>		
						<i>White</i>	<i>Water</i>	<i>Yellow</i>
Ibadan	..	..	..	..	..	34	16	8
Benin	..	..	..	..	..	14	1	8
Umudike	..	..	..	..	..	2	—	1
Oturkpo	..	..	..	..	..	3	—	—
Total	..	..	..	..	..	53	17	17

Small collections of wild yams are being maintained for future botanical work. Unfortunately a permanent site for this work is not yet available and there is a risk of losing the material due to annual harvesting and propagation.

Under the conditions at Umudike the two diosgenin bearing species, *Dioscorea composita* and *D. floribunda* are growing satisfactorily; *D. floribunda* would appear to be the more vigorous. Seeds have been collected from *D. floribunda* and have shown a high percentage of germination.

Progeny from open-cross seeds are being multiplied for progeny yield trials. There are 96 white yam progeny and several of these are showing promise of high yields.

Variety Yield Trials

Umudike.—Variety trials were carried out on white, yellow and water yams. Spacing in all trials was 3 feet on 4 feet ridges and 12 $\pm$ 2 ounce setts were used. Establishment and growth were good in all trials.

Ten varieties of white yam were tested for yield. Four varieties Ji-Okom (Owerri), Gwaguzu (Abuja), Banjabudi (Minna) and Basuba (Keffi) gave calculated yields of 5.6 tons per acre and over. Ji-Okom gave the highest yield of 6.5 tons per acre; this popular variety was collected in 1963 and is a short fat yam.

Six varieties of yellow yam collected from the Eastern Region were placed in a variety yield trial. The yield were lower than last year. The highest yielding variety Eseso (6.6 tons/acre), was collected from Owerri. This trial is to be repeated.

Five sweet and two bitter varieties of cluster yam were placed in yield trial. The yields were low and no significant differences in yield were found. The cluster yam is only of local interest and yield trials on this species (*Dioscorea dumetorum*) are to be discontinued.

Moor Plantation.—Ten varieties of white yam selected from local collections were placed in yield trial. The yields in this trial were low due to poor soil conditions. Variety Tegunde (Ogbomosho) gave the highest yield of 4.4 tons per acre followed by Iyawo (Ibadan) and Pwasembakor (Yandev); there was no significant yield differences between these varieties.

The yields of the eight varieties of yellow yam tested in a yield trial were low. The low yields can be attributed to poor soil conditions and to drought after planting. In general the yellow yam does not give high yields under the environmental conditions found in Ibadan. Only where there is prolonged rainfall of from 9 to 10 months are satisfactory yields obtained. In 1963 rainfall was in short supply during the critical months from germination until established vine growth. Variety Igangan (Ilora) was the highest yielding and gave a calculated yield of 4.4 tons per acre and was significantly superior to all other varieties ($P=0.05$) except Agege Local and Igbinchue (Benin).

Eight varieties of water yam (*D. alata*) were tested for yield. A contributing factor to the low yields obtained was the attack by anthracnose disease. The best varieties were Onitsha, Ibadan and Yandev Locals. Variety trials on this species are to be temporarily discontinued whilst more information is obtained on the pathogen.

Ilora.—Four high yielding selections were tested and yields, although lower than previous years, were quite good. The trial was carried out on a soil with a high content of gravel. There were no significant differences in yield. The variety, Ibadan local gave 8.2 tons per acre followed by Ilora local, Iyawo (Ibadan) and Usekpe Ekpe (Udi) which gave the lowest yield at 5.7 tons per acre.

Agege.—Six varieties of water yam were planted at two different times to investigate the effect of time of planting on yield and on the incidence of anthracnose disease. The Agege local variety gave the highest yield, significantly greater than Jimba and Gamaarami varieties. Early planting was significantly better ($P=0.001$) than late (table II), also significant was the interaction of variety with time of planting ($P=0.05$).

Table II Variety X time of Planting-Yields in tons acre

Variety	Time of Planting	
	13-2-63	19-3-63
Gamaarami (Maigana)	3.4	2.1
Ingyawa (Yandev)	4.9	1.6
Aribiya (Ijebu-Ode)	4.5	2.8
Jimba (Umuahia)	4.2	1.8
Onitsha Local	4.2	2.5
Elekuru (Agege)	4.6	2.7

Benin (W.A.I.F.O.R)—Five local varieties of white yam were tested for yield in their second year of trial. The order of yield was the same, variety Arebu gave a calculated yield of 9.4 tons per acre which was not significantly different from Amifu 8.8 tons per acre. The lowest yielding variety was Iyawo 7.3 tons per acre. Arebu, the highest yielding variety, produced only 57.6 per cent of ware tubers whilst varieties Omifu and Emowe produced 72.3 and 72.6 per cent respectively.

There was no significant difference in the yields of the three local varieties of yellow yam, Ufua, Ikpen and Egbenehikure. The yields were 8.5, 8.0 and 8.0 tons per acre respectively.

Riveraine Provinces, Northern Nigeria.—Variety trials on riveraine varieties were carried out at Ilorin, Kabba, Osara, and Yandev. Collection and multiplication plots were observed at these stations and at Mokwa, Ochanja, Oturkpo, Kwali, Lafia and Wukari.

Ilorin.—Fourteen varieties of white yam were tested for the third year. Varieties Gwaguzu, Boki and Awala have again shown themselves to be the highest yielders with no significant yield differences between them—8.1, 7.9 and 7.4 tons per acre respectively. The mean yields of these varieties over three years are 6.7, 6.6 and 5.8 tons per acre respectively.

Osara.—Variety Okumaha (9.1 tons/acre) was the highest yielder of the six varieties in trial although not significantly greater than Andori (8.2 tons/acre) and Gwagwa (7.7 tons/acre).

Kabba.—Two varieties Kokorogboko and Wutse were added to the six varieties from the yield trial from the previous year. Varieties Kokorogboko (8.6 tons/acre), Boki (8.5 tons/acre) and Gwaguzu (8.4 tons/acre) were the highest yielding varieties.

The best yielding varieties from Osara, Kabba and Ilorin are planted in a variety trial at Mokwa, Ilorin and Osara. The collection of varieties, previously planted at these stations is being maintained at Mokwa.

Yandev.—Ten riveraine varieties were tested in a repeat of the 1962 trial. Variety Boki (9.7 tons/acre) gave a significantly higher yield than Tar (7.3 tons/acre). Seasonal variation changed the order of yields of the ten varieties, however, Boki maintains its leading position followed by Gwaguzu and Atolube. A yield trial has been planted at Yandev which includes selections from Lafia and Oturkpo along with the ten varieties from the 1963 trial at Yandev.

PLANT BREEDING : CASSAVA

Collection and Survey

The survey questionnaire sheets for Northern and Western Regions have been completed and the data will now be processed for publication.

The collections of local varieties are progressing favourably and plots of these have been established at Nekede, Abak, Benin, Ibadan, Mokwa, Yandev, Osara and Samaru. Further collections are being made and will be evaluated for use in future breeding work.

National Collections

The project of constructing a key to the 450 varieties in the collection is progressing. Characters are being checked for their constancy and this can only be done at particular growth stages. Promising varieties are being selected for testing in replicated trials.

Multiplication and Progeny Testing

The programme continues of multiplication, testing and selection of the progeny from the annual pollination series. The results of these trials are summarised. Previously progeny were sent for testing to each of the 3 selection centres at Mokwa, Benin and Ibadan but the same progeny were not sent to each centre. It is intended that each of these centres will hold the same progeny. Because of this change stations may be carrying two trials on the same pollination series until all the progeny of a particular series is tested under each selected environment.

1957-58 Pollination Series.—Trials on this series now in the third and fourth stages of multiplication, were carried out at Mokwa, Benin, Ibadan and Umudike. Yields were very good at Mokwa and Benin; the highest yields being 10.9 and 9.1 tons/acre respectively. At Ibadan and Umudike the yields were less satisfactory, the best yields being 4.7 tons/acre at Ibadan and 5.5 tons/acre at Umudike. The yields of a few progeny exceeded the parents except at Benin where 53101 a parent, was superior but not significantly. At every station progeny outyielded the local variety and twenty-three of these progeny have been selected for further trial on a basis of high yield, mosaic resistance or a combination of these two factors.

1958-59 Pollination Series.—In this series of pollinations now in the third and fourth stages of multiplication, there were three objects; (a) high yield (b) mosaic resistance (c) high protein content.

In pursuit of objects (a) and (b) multiplication and selections were carried out at the four selection centres. Selections were based on mosaic resistance and on the relative yield to the controls, which in these trials were the parent varieties. Ten selections at Benin, 23 at Ibadan, 7 at Mokwa and 22 at Umudike were selected for further yield trials. Borderline selections were placed in collections for further observation.

The hybridisation of *Manihot melanobasis* and *M. utilissima* was carried out to increase the protein content of cassava food. A limited number of analyses were carried out in 1962 and selections of high protein and high yield were made. Further analyses are necessary and when this has been done the selection programme can continue. Until then, the progeny are being maintained in collections and observed for yield and general growth characters.

1959-60 Pollination Series.—Two series of pollinations were carried out in 1959-60. The first of these was to study the inheritance of male sterility, but after the first stage selection it was not found possible to continue with this work. From the first stage 387 clones were selected on the basis of yield and mosaic resistance. Scoring for mosaic disease was carried out when the plants were 3 and 6 months old. From this second stage collection 232 progeny were selected for high yield, with or without mosaic resistance. These have been planted in the third stage of multiplication.

1960-61 Pollination Series.—This series now in the second stage of multiplication, was a continuation of the previous years' project. The yields were not satisfactory due to the poor soil conditions. From the male sterility plot 73 clones out of 178 were selected on a yield basis for further testing. Along with these 76 clones were selected out of the 296 progeny planted for the study of mosaic and yield inheritance.

1961-62 *Pollination Series*.—Selections at Benin, Mokwa, Ibadan and Umudike were crossed to combine high yield with mosaic resistance and to study the inheritance of varietal characters. The seeds of these pollinations were germinated at Ibadan and transferred to the nursery. Planting material of 780 progeny have been transferred to Umudike for further observations and selection.

1962-63 *Open-Cross-Series*.—Selected varieties having desirable characters of yield, mosaic resistance and growth habit were allowed to cross freely in an isolation plot. Approximately 1,000 seedlings have been planted in the field for 1st stage selection.

Variety Trials (1962-63)

Eastern Nigeria.—Variety trials were harvested from Abak, Abakaliki and Nekede. The variety trials at Abakaliki and Nekede, which were planted in 1961, have been left until 1963 owing to poor growth. In all trials selected hybrids and varieties were planted with popular local varieties.

The yields were low at Abak (4.6 tons per acre) but satisfactory at Nekede (10 tons per acre) and at Abakaliki (7 tons per acre). At Nekede and Abakaliki four hybrids (60447, 60506, 60503 and 60520) gave significantly higher yields than the popular local variety and gave equal yields with the local variety at Abak. These new hybrids were superior to 37065 (GCH 7) which is the recommended variety for the Eastern Region.

Western and Mid-Western Nigeria.—Five variety trials were planted, one each at Agege, Ilora, Ibadan, Benin and Kwale. In each case the object was to compare the most popular local variety with the yields of selected hybrids and varieties.

The recommended variety, 53101, maintained its position (Table III) as a consistent high yielder when compared with other varieties in previous trials. However, the yield figures for each trial showed that one of the following hybrids—60447, 60444, 60448 and 60488—was for a second year, superior to 53101.

Table III.—Yield (tons/acre) of selections and local varieties at six stations in Western Nigeria

<i>Station</i>	<i>Highest yielding variety</i>	<i>Highest yield</i>	53101	<i>Local Variety</i>	<i>Station Average</i>
Agege	60447	13.5	10.1	5.5	8.5
Ibadan	60447	10.7	10.0	10.0	8.0
Ilora	60444	8.4	6.4	4.8	6.2
Akure	60448	14.0	11.7	6.1	9.1
Benin	60488	13.3	12.0	7.5	11.1
Kwale	60444	11.6	9.8	8.7	8.2
Regional Average ..	—	11.9	10.0	7.1	8.5

The variety Congo (44086) is popular for its good cooking qualities but it has never been considered as a high yielder except in the Benin and Akure areas. Because of the general interest in this variety it was decided to test its yielding ability. It is shown (Table IV) that it does not compare favourably with other selections.

Table IV.—Yield (tons/acre) of the variety Congo compared to station average and highest yield station in Western Nigeria

<i>Stations</i>		44086	<i>Place in Trial</i>	<i>Station Average</i>	<i>Highest Yield</i>
Agege	.. ..	6.9	8	8.5	13.5
Ibadan	.. ..	6.9	7	8.0	10.7
Ilori	.. ..	4.0	9	6.2	8.4
Akure	.. ..	6.7	8	9.1	14.0
Benin..	.. ..	9.3	9	11.1	13.3
Kwale	.. ..	6.0	10	8.2	11.6

Northern Nigeria.—Variety trials were carried out at Yandev, Osara, Ilorin, Mokwa and Samaru and in each trial the object was to compare the yields of selected varieties and hybrids with the popular local variety.

At every station except Ilorin the yields were high. The newly introduced hybrids (60509, 60480, 60448 and 60447) gave significantly higher yields than the local variety (Table V).

Table V.—Yields (tons/acre) of hybrids and percentage yield in comparison to local variety

<i>Station</i>				<i>Highest yielder</i>	<i>Yield</i>	<i>Percentage of Local</i>	<i>Station Average yield</i>
Mokwa	.. ..	..	..	60509	11.0	130	9.0
Yandev	.. ..	..	..	60447	10.4	186	7.5
Samaru	.. ..	..	..	60480	9.2	112	6.3
Osara	.. ..	..	..	58382*	7.5	134	6.2
Ilorin	.. ..	..	..	60448	3.0	188	2.6
				60509	3.0	188	
				58382	3.0	188	
Regional Average	.. ..	..	..	—	6.7	—	6.3

*Local

Samaru

The object of the programme of work at this station is very different from that of Southern stations. In the north a sweet type of cassava is preferred which can either be eaten raw or boiled before eating. Sweet varieties have been introduced into Samaru from Eastern Nigeria and have been found to maintain their sweetness and give satisfactory yields of about 8 tons per acre. These sweet varieties are undergoing further testing.

Cassava Mosaic Observation

In the 1959 Annual Report of this department it was reported that primary infection of cassava mosaic virus disease caused a significant reduction in yield. The trial was repeated using five local varieties (Table VI). Significant differences in yield were obtained between plants grown from healthy cuttings and plants grown from infected cuttings.

Table VI—The effect of primary infection of cassava mosaic virus on the yield (tons/acre) of 5 varieties

Variety					Clean cuttings	Infected cuttings	Percentage difference
Samaru Dan Warri	..	..	..	..	8.2	7.3	0.10
Zuru Local	..	..	..	..	8.9	4.4	51.00
Doneji	..	..	..	..	8.0	5.3	34.00
Gama Gari	..	..	..	..	7.8	2.7	65.00
Zonkwa Dan Warri	..	..	..	..	7.2	6.7	0.07
Average	..	..	..	..	8.6	5.3	30.03

PLANT BREEDING : SWEET POTATOES

Progeny Selection

Of the 89 stock varieties in the breeding plots fifteen had to be discarded due either to poor growth, severe virus attack or both these factors.

From the open cross seeds collected in 1962 one hundred and eighteen were transplanted into the field for the 1st stage selection. Observations were carried out twice, in October and November, and fourteen progeny were rejected on the basis of poor growth and virus infection; a further four have failed to establish in the nursery. The remainder will be tested for yield in this year's trials.

Variety Trials

Umudike.—Eight varieties were tested for yield. The highest yield was obtained from variety 2342 (a hybrid) which gave 5.4 tons/acre gross, and 4.2 tons per acre ware tubers. The yield was not significantly greater than variety 2291 (B5) and 2292 (Large leaves) which gave 4.5 and 4.1 tons per acre respectively.

Ibadan.—Nine varieties were included in the yield trial. Yields were not good and weevil attack due to late harvesting caused a high percentage of damage tubers.

Three varieties 2304 (Lagos White B), 2291 (B5) and 2330 (hybrid) gave yields of 4.4, 3.7 and 3.4 tons per acre respectively. Variety 2291 has been in trial for four years with a mean yield of 4.1 tons per acre and would appear to be a steady yielding variety.

PLANT BREEDING : COCOYAMS

The botanical characteristics were noted of 14 varieties of *Xanthosoma sagittifolium* and 11 varieties of *Colocasia esculenta* for the construction of a key to local varieties.

AGRONOMY OF ROOTCROPS

The aims of the agronomic trials are to improve yields of rootcrops by means other than by breeding. The experiments are carried out to evaluate particular aspects of local cultural practices and to undertake investigations which may have a practical and economic importance in Nigerian farming in the present and future.

Yams

Ridge Type and Width Studies.—Experiments carried out between 1960 and 1962 on the effect of different spacings within a 3 feet ridge width showed that, irrespective of sett weight, decreasing the spacing distance increased the nett and gross yields but decreased the average

weight per tuber. Preliminary investigations were begun in 1962 at Ibadan, and were continued this year at Umudike and Ibadan, to study the effect of varying the ridge width while maintaining a constant unit area of 12 square feet per stand. At Umudike, the 3 feet ridge put up with the potato mould-board ridger was used as standard and compared with two types of 4 feet ridges using the trailing Gobel Disc and North American Bedder Disc. and with 6 feet ridges put up by the later implement. Significant differences in yield were not found between ridge types although increased yields were found with the 6 feet ridges (5.2 tons/acre) followed by 4 feet Gobel (4.8 tons/acre), 3 feet (4.7 tons/acre) and 4 feet Bedder Disc (4.6 tons/acre).

In the light of the results of this experiment at Umudike a modified experiment is being laid down. The trailing Gobel disc is not being used as it was not satisfactory on newly cleared land—it was too easily dislodged from a straight line and made an uneven ridge. The 3 feet mouldboard, although fragile for newly cleared land, is being retained because of its popularity on many Government stations. The Bedder disc, a heavy and robust implement, is satisfactory on newly cleared land and does not require the land to be exhaustively cleaned before ridging. The implement puts up a round and closely packed ridge and the ridge does not show the same tendency to erode as those put up by the mouldboard ridger.

At Ibadan the experiment carried out in 1963 compared three ridge widths of 3, 4 and 6 feet and sub treatments were rounded and steep sided ridges at the 3 and 4 feet ridge widths. The trial showed the superiority of the rounded 4 feet ridge (7.2 tons/acre) and the lowest yield was obtained from the steep sided ridge (5.8 tons/acre) put up by the mouldboard. The rounded type ridge gave a 11.5 per cent increase in yield over the steep sided ridge.

Parent Tuber Weight.—It has been suggested that the farmers prefer for planting setts to be cut from small tubers because the setts cut from the large tubers do not grow as vigorously or yield as highly; also, they wish to retain the large tubers for food. In this experiment 12 ounce setts were cut from three weight groups of tubers; tubers weighing up to 2 lbs; tubers 2 to 3.5 lbs; tubers greater than 3.5 lbs.

It was noted that the growth vigour was greatest in plants grown from setts taken from small tubers and this was reflected in yield 5.2, 4.6 and 3.7 tons/acre respectively. Significant differences were found between the yield obtained from setts cut from tubers weighing less than 2 lbs and tubers weighing more than 3.5 lbs ($P=0.01$) and between setts cut from tubers weighing 2 to 3.5 lbs and greater than 3.5 lbs ($P=0.05$).

Topping v No Topping.—In many areas it is the local practice to top yams either for seed yam production or for food. In this trial the yellow yam variety Okuocha was planted at 3 and 4 feet on 4 foot ridges, and 3 and 4 feet on 3 foot ridges. Topping increased the yield by 10 per cent which was significant at 5 per cent. The best treatment was 3 feet on 3 foot ridges with topping (Table VII).

**Table VII.—The Effect of Spacing and Topping on
Yield of Yams (tons per acre)**

Row Width (ft.)	..	..	..	..	4		3	
					3	4	3	4
No topping	..	..	..	..	5.0	3.8	5.1	5.1
Topping	..	..	..	..	5.1	4.0	6.4	5.2

Species—Spacing Trial.—This was a preliminary investigation into the effect of different spacings on the yield of four species of yam—white, yellow, water and cluster yam. Planting was at 3 and 4 feet apart on 3 and 4 feet ridges.

Yellow yam gave significantly higher yields (6.4 tons/acre) than cluster yam (4.9 tons/acre). The best spacing distance was 3 feet on 3 foot ridges (5.8 tons/acre) followed by 3 feet on 4 foot ridges (5.2 tons/acre), in both cases significance was at 1 per cent. The interaction of species and spacing was significant at 5 per cent (Table VIII). It should be noted that this result is in agreement of earlier work (1960-62) where it was shown that closer spacing gave higher yields but at the expense of tuber size.

Table VIII.—The effect of different spacings on the yield of 4 species—tons per acre

<i>Spacings</i>	<i>Species</i>			
	<i>White</i>	<i>Yellow</i>	<i>Water</i>	<i>Cluster</i>
3' on 4 ft ridges	4.8	6.9	3.7	5.4
4' on 4 ft ridges	3.4	5.6	3.8	3.4
3' on 3 ft ridges	5.3	7.1	5.2	5.6
4' on 3 ft ridges	4.4	6.0	3.8	5.2

Staking Trial.—In 1962 a staking trial was carried out at Ilorin to investigate the effect on yield of different heights of staking. The treatments were no staking, 2, 4 and 7 feet staking. The 2 ft. staking was a horizontal pole supported 2 feet from the ground by two uprights; this was an attempt to reproduce the local custom of guinea corn stalks bent into a trellis. There were no significant differences between treatments.

In 1963 this experiment was repeated at Ilorin and at Ibadan, Benin and Umudike. The no staking treatment was not included at the last three stations because of the higher rainfall which would probably cause rotting of vines on the ground. Spacing at all stations was 4 feet on 3 foot ridges and the popular local variety was used in each case.

Only at Benin was there found to be a significant differences in yield although at other stations there was a general trend of increased yield with increased height of staking (Table IX).

Table IX.—The effect of height of staking on the yield at 4 stations—tons/acre

<i>Treatment</i>	<i>Station</i>			
	<i>Umudike</i>	<i>Benin</i>	<i>Ibadan</i>	<i>Ilorin 1962 and 1963</i>
No Staking	—	—	—	6.1
2 feet	4.6	5.5	5.4	7.1
4 feet	4.9	6.9	5.7	7.3
7 feet	4.7	8.3	6.6	7.1

At Umudike the same staking treatments were carried out on 4 and 6 foot ridges. Only on 6 foot ridges was a significant response found. Two types of four foot ridges were used and the results shown (Table X) are the averages of the two.

Table X.—Effect of height of staking and ridge width on yield—tons per acre

<i>Staking Height (Feet)</i>								<i>Ridge—Width (Feet)</i>		
								3	4	6
2	..	..	..	..	..	..	..	4.6	4.6	4.6
4	..	..	..	..	..	..	..	4.9	4.8	5.2
7	..	..	..	..	..	..	..	4.9	4.9	6.0

The method adopted for 2 foot staking has the disadvantage of being initially more costly in labour to carry out than the other methods but this is offset by the little restaking required after high winds. It may be possible to investigate the use of rope between low upright posts and this would considerably reduce costs of staking.

Ridge Width—Time of Planting.—This experiment was carried out at Mokwa. Planting was carried out in November (early) and April (late) on 6 and 3 foot ridges using seed yams and setts of 24 and 12 ounces.

Early November planting on 6 foot ridges gave significantly higher ($P=0.01$) yields than late planting on 3 and 6 foot ridges ($P=0.01$) and early planting on 3 foot ridges ($P=0.05$). Cut setts of 24 ounces gave significantly higher yields than 12 ounce setts ($P=0.01$) and seed yams ($P=0.01$). However, seed yams were superior to 12 ounce setts ($P=0.01$).

Table XI.—The effect of sett weight, ridge width and time of planting on yield tons/acre

<i>Treatment</i>				<i>Sett</i>		
				12 oz.	24 oz.	Seed yam
November planting on 3 foot ridge	..	..	..	6.2	8.5	9.3
November planting on 6 foot ridge	..	..	..	9.3	12.5	11.0
April planting on 3 foot ridge	..	..	..	5.5	7.0	7.0
April planting on 6 foot ridge	..	..	..	4.7	5.8	5.8

It was not possible to obtain for this experiment a constant seed yam weight. Future experimental work must take this into consideration as well as the optimum and most economic sett weight.

Disease Control Trial.—Preliminary investigations were begun on control methods of anthracnose disease of water yams. The disease can destroy completely the growing vines. Infection is usually obvious in early July and spreads rapidly with the high rainfall normally found during this month. July is also the month of most rapid growth of the vine. In 1963 the prevalence of the disease was less at Umudike than in previous years but was high at Ibadan and Agege.

At Umudike the tubers were planted in March and April and in February and March at Agege. Time of planting did not affect the degree of attack. It was observed that with later planting the vines had not reached as an advanced stage in growth as those planted early

and consequently the yield was less. Spraying of the vines with a copper fungicide, Perenox was done in an attempt to control the disease. Phytotoxic effects to the spray were noted which became more severe as the number of sprayings were increased.

Three other fungicides Cuman, Spersul and Cuprantol were tried at 14 day intervals on groups of three stands. Cuprantol was stopped because of phytotoxic effects and later, Spersul because it did not control the disease. Cuman was found to be effective.

Storage Observations.—Two small experiments were carried out to observe the weight losses during storage between and within species. In the first experiment ten tubers were taken from six varieties each of white and water yam, and five varieties each of yellow and cluster yam. The tubers were numbered and stored on a shelf under normal conditions to be found in barn storage. Tubers were weighed individually at 14 day intervals. The storage period was 238 days from the time of harvest.

The greatest weight loss, 54.2 per cent was found in the cluster yam, and much less in the yellow yam 42.9 per cent, white yam 39.23 per cent and water yam 32.96 per cent. There were differences within species some varieties losing considerably less weight than others. Although the weight loss was the greatest in the cluster yam this species had the fewest number of tubers discarded because of storage rots, followed by tubers of water yam.

Acceptability tests were carried out after storage on the remaining tubers of white, yellow and water yam species. It was generally agreed that water yams were preferable and next in favour were white yams, the tubers of yellow yam which appeared outwardly healthy were generally considered unpalatable.

In the second experiment 200 varieties of white yam were stored for about 16 weeks and observations were taken on the time of sprouting from harvest. Varieties fell into two groups ; tubers which sprout within 40 days from harvest and those which sprout after 50 days. Further work will have to be carried out to determine whether there is a connection between this observation and the storage ability of varieties.

Cassava

Type of Cutting.—The cassava stem branches dichotomously and cuttings for planting are taken either from the main stem, from the first branches (primaries), from the second branches (secondaries) or from the leafy top of the plant. It is not known which of these cuttings gives the best germination and highest yield. Three previous experiments had been carried out on this problem with conflicting results and this years trial was laid down with the object of resolving these differences.

In the trial, cuttings were taken from the base and top of main stem, base of primary branches, and tops of branches. The cuttings were taken from low, medium and high branching varieties.

There were no significant differences in yield between varieties and types of cuttings. Only in the medium branched variety was there found to be a significant difference in yield in favour of basal stem cuttings.

From the four experiments carried out it can be shown that improved yields are obtained by taking cuttings from the main stem in preference to cuttings from branches. At present, there is little positive indication that yield is affected by taking cuttings from plants having different growth habits. This factor may have greater importance after experiments on planting methods and spacing have been completed.

Cutting and Planting Method.—In some parts of Eastern Nigeria it is a local farming practice to use the tops of the cassava plants for planting in the belief that this method gives more rapid growth and higher yields.

Stem cuttings and leafy tops were taken each from low, medium and high branched varieties. The tops were planted erect and the stem cuttings oblique.

There was no significant difference in yield between treatments. Apart from an initial advantage in the growth of tops the yields were lower than plants grown from stem cuttings (Table XII).

Table XII.—The effect of yield (lbs/plot) of types of planting method and growth habit

<i>Cutting and Planting Method</i>		<i>Growth Habit</i>			<i>Mean</i>
		<i>Low</i>	<i>Medium</i>	<i>High</i>	
Tops (erect) ..	..	112	72	51	78
Stem (oblique) ..	..	114	96	55	88
Mean	..	113	84	53	—

Fertilizer Trials.—There is an indication from previous work that a greater response to fertilizer is obtained from hybrids than local varieties. To test this, experiments were laid down at Nekede, Abak and Abakaliki using the recommended fertilizer for rootcrops for the Eastern region of 10 : 10 : 20 (N.P.K.) applied at the rate of 300 lbs per acre.

There was a marked difference in growth in favour of the plots treated with fertilizer and an increased yield of 50 per cent was obtained over plots of the same variety on which no fertilizer was applied. The increase was more noticeable with hybrids than with local varieties. Unfortunately due to the shortage of planting material it was not possible to plant the same treatments at the three stations and, therefore the response of the same variety to fertilizer under different environmental conditions could not be fully assessed.

Sweet Potatoes

Beds v Ridges.—The trial was a preliminary investigation into the effect on yield, and ware tuber production of growing sweet-potatoes on beds as opposed to ridges. The ridge width was 4 feet and beds were made by combining by hand, two-four-foot ridges. Three varieties were used.

Beds (4.0 tons/acre) gave a significantly higher yield ($P=0.01$) than ridges (3.1 tons/acre). The highest yielding variety 2296 (4.3 tons/acre) was not significantly greater than 2340 (3.7 tons/acre) but greater ($P=0.01$) than 2294 (2.7 tons/acre). The interaction between varieties and ridge types was not significant. The difference in ware tuber production was only 6 per cent in favour of beds.

Time of Planting and Harvesting Trial.—The best time of planting and harvesting sweet-potatoes are not known for conditions at Umudike. In this trial one variety was planted at 4 weekly intervals beginning in April and harvested at 120, 140, 160 and 180 days from planting. The April planting treatment was discarded because of extremely poor establishment.

Yields were low and this was probably due to the variety used for the experiment. Establishment was highest for the July planting (81.0 per cent) and lowest for May (45.0 per cent) but

the yields were lowest for July planting. The yields of May and June planting were significantly higher ($P=0.01$) than for July with only a slight difference in yield between these two planting dates. Harvesting 160 days from planting was better than 140 days ($P=0.01$) but not significantly better than 180 days. The interaction between time of planting and time of harvesting was not significant.

Fertilizer Trial.—There is meagre information on the fertilizer requirements of sweet-potatoes in Southern Nigeria. When grown on newly cleared land the tubers are frequently found to be misshapen and enlarged, in some cases to the size of a football. Therefore, in co-operation with the Research Section of the Eastern Region Ministry of Agriculture a pilot experiment was carried out at Umudike in which nil fertilizers and high dressings of Calcium, Nitrogen, Phosphorus and Potash were applied. The rates per acre were 112 lbs Lime (100 lbs Ca), 300 lbs Sulphate of Ammonia (56 lbs N), 500 lbs Superphosphate (90 lbs P_2O_5) and 300 lbs Muriate of Potash (92.6 lbs K_2O).

The experiment was not satisfactory due to the uneven site. Also severe storm damage washed out some of the cuttings and necessitated replanting. In spite of this an indication of the responses was found in particular to potash which was enhanced in the presence of Nitrogen and Calcium. This experiment is to be repeated.

Weevil Control Experiment.—It has been found at Moor Plantation (Ibadan) that sweet-potatoes, planted in June are severely attacked by the sweet-potato weevil (*Cylas puncticolis*) if harvesting is delayed after 160 days from planting.

In co-operation with the Entomology Division a trial was conducted to test control method by means of insecticides. Treatments were controlled, Telodrin 0.5 per cent applied a planting, Rogor 40 and Dieldrin 20 per cent emulsion applied at approximately ten weeks from planting when good vine growth was present, and Telodrin emulsion at the time of tuber initiation. Initial establishment was poor due to a dry period after planting, supplying was carried out and subsequent growth was good. However, attack by weevils was not observed on the control plots. The low incidence of attack may be accounted for by the late planting and prolonged rains experienced this year. The trial is to be repeated.

Cocoyams

Cormel Production Trial.—Four varieties of *Xanthosoma sagittifolium* (Taro), commonly regarded as cocoyams, were planted at 2 and 3 feet spacing on 4 foot ridges. Also included as a separate treatment was the use of cut corms and cormels (bulbils) as planting material.

The yields obtained were low and this is attributed to the poor soil conditions. Two varieties, 2205 and 2197 showed better growth and coverage than varieties 2193 and 2204. No significant differences between treatments were noted. Observations show that there was a greater reliability in germination, a higher yield and a higher number of cormels produced by using whole bulbils rather than cut corms.

CHAPTER IX

REPORT ON THE STATISTICS AND RECORDS DIVISION

STATISTIC

Analysis of Experiments

With the establishment of this division in July 1963, it has been possible to clear up a backlog of unanalysed experiments in the Department. On the whole the Division helped with the analysis of some 83 experiments as shown in Table I.

Table I.—Numbered of Experiments Analysed

<i>Division</i>	<i>Number of Expe- riments</i>
Agronomy	49
Botany	26
Entomology	1
Pathology	1
Chemistry and Soils	3
Root Crops	3
TOTAL	83

In the Citrus rootstock trials planted at Moor Plantation in 1932, no more than summarising of the data has been attempted as these trials, and no less their records, suffered so much mishap during their 21 years existence that the accumulated data are too incomplete to be worth the trouble of any rigorous statistical analysis. The results have been summarised and reported below in order to throw some light on certain features of the rootstocks.

Design of Experiments

Most experimenters have been able to design their own experiment. When advice was sought simple designs have been recommended.

Two instances when slightly complex designs were recommended were in the maize breeding programme where the large number of varieties necessitated the use of lattice designs and the maize fertilizer trial at Agege where a half plaid square was dictated by practical difficulties.

GENERAL

The Statistician helped with the analysis of Experiments from other research organisations.

RECORDS

A start has been made at putting together records of past work.

With the agreement of all the regions to adopt a common proforma for experimental summaries, it is now possible to transfer summaries of experiments from all over the country on to clip cards thus making for more permanent records and facilitating classification and sorting.

Summaries of experiments from Northern Region which has the greatest number of reported and well numbered experiments have been classified. They number 3,012 altogether covering the period 1948 to date.

A SUMMARY OF THE RESULTS OF THE 1932 ROOTSTOCK TRIALS ON MOOR PLANTATION

Introduction

Rootstock trials for sweet orange and grapefruit were first established at Moor Plantation in field MA6N in 1932. The stocks tested were sour orange, sweet orange, acid lime, grapefruit, shaddock, hybrid lemon (originally thought to be rough lemon), tangerine and mandarine. The scions used were Ruby Blood (MP64) for the sweet orange and a local unnamed seedy variety (MP2) for the grapefruit.

The trees were budded low, generally at about twelve inches from the ground. No fertilizers were used and the original Calopogonium cover crops eventually gave way to grass.

A single tree plot was adopted in a randomised block layout. There were six blocks each containing seven trees. All but the Mandarine and Tangerine stocks were replicated six times. The Mandarine and Tangerine stocks, regarded as being closely allied were each replicated three times in the sweet orange trial, while there were four replications of tangerine and two of Mandarine in the grapefruit trial. The trees were spaced at 27 feet triangular giving 70 trees per acre. No formal statistical analysis other than simple tabulation of the results has been attempted owing to gross incompleteness of data.

Sweet orange root stock trial

Yield.—At the end of the 1939/40 season, Murray analysed the total yields for the first four years cropping and reported his results in Tropical Agriculture Vol. 18 No. 10, 1941. Examination of available records shows that his analysis was based on total yield comprising both good and bad fruit. He found significant differences between the stocks in both the sweet orange and grapefruit trials with sour orange and sweet orange as the best stocks for both scions. These results also hold good for marketable fruits in the first four years of cropping, Table I (a).

Table I.—Average Annual Yield in Number of Marketable Fruits per Tree

(a) *Sweet Orange (Ruby Blood)*

Stock	Age in Years						
	4-7	8-11	12-15	16-19	20-23	24-27	28-30
Grapefruit	310	472	599	556	264	135	248
Hybrid Lemon	201	258	342	286	128	100	112
Shaddock	312	342	603	476	109	133	82
Sweet Orange	597	818	1,313	822	245	133	135
Sour Orange	655	777	1,672	1,067	513	325	79
Acid Lime	475	896	1,351	627	557	368	417
Mandarine	489	917	1,418	1,338	1,071	1,228	1,571
Tangerine	472	517	1,061	1,063	830	947	1,129

(b) *Grape Fruit*

<i>Stock</i>	<i>Age in Years</i>						
	4-7	8-11	12-15	16-19	20-23	24-27	28-30
Grapefruit	358	688	871	565	448	227	387
Hybrid Lemon.. ..	280	599	465	334	198	77	104
Shaddock	238	545	475	174	37	26	—*
Sweet Orange	388	716	770	368	193	141	154
Sour Orange	481	1,135	999	550	992	246	179
Acid Lime	337	996	691	311	248	14	—*
Mandarine	419	1,135	982	444	429	284	97
Tangerine	395	534	662	439	733	758	333

* All trees dead.

The mean yield per year per tree has been tabulated in Table (a) and (b) instead of the total yield for each period because of inequalities in number of trees.

In the sweet orange trial the peak yield period seems to be between the age of twelve and fifteen years for all stocks except Mandarine and Tangerine which do not show any marked optimum period. The cropping of these two stocks has been uniformly good all throughout and was still high at the time of felling the trees in 1963.

While every tree of the other stocks attained its optimum before the age of 18, the Mandarine and Tangerine trees attained their optimum after eighteen. For all the stocks except Mandarine, the best individual yield occurred when the tree was eighteen. A Mandarine tree MA 71 attained its optimum yield of 3,391 fruits at 28 and as it was still doing well at the time of cutting down the trees, it has been left for further observation, Table II.

Table II.—Yield of best Tree for each Stock

<i>Tree No.</i>	<i>Stock</i>	<i>Maximum yield</i>	<i>Age</i>
MA 71	Mandarine	3,391	28
MA 60	Sour Orange	2,941	18
MA 52	Tangerine	2,717	18
MA 66	Acid Lime	2,658	13
MA 48	Sweet Orange	2,335	18
MA 62	Grape fruit	2,263	18
MA 46	Shaddock	1,497	18

During the peak period, Sour Orange appeared the best stock but thereafter declined rapidly. This decline has been attributed to an attack of a virus disease Tristeza reported to have reached Ibadan during the last 23 years. (Federal Department of Agricultural Research Annual Report 1958-59).

Growth Vigour—When the scions girth measurements were taken in 1953, Mandarine and Tangerine Stocks had the highest figures and, at the end of 1954, twenty two years after planting, the foliage of the scions on these two stocks was still deep green in contrast to the appearance of other stocks. It would thus appear that Mandarine and Tangerine are the most vigorous stocks.

At an early ages of the trees Murray found that these two stocks had good stock scion compatibility as measured by the difference in stock and scion girth at 3 inches below and above the bud union and that the yield seemed to be correlated with this compatibility.

Table III.—Mean Girth in inches at 21 years of age

(a) <i>Sweet orange</i>					(b) <i>Grape fruit</i>				
<i>Stock</i>				<i>Girth</i>	<i>Stock</i>				<i>Girth</i>
Mandarine	..	..	..	45.0	Mandarine	..	..	..	58.2
Tangerine	..	..	..	41.3	Sour Orange	..	..	..	49.3
Sour Orange	..	..	..	39.9	Sweet Orange	..	..	..	44.8
Sweet Orange	..	..	..	39.4	Acid Lime	..	..	..	44.6
Acid Lime	..	..	..	32.7	Tangerine	..	..	..	41.9
Grape fruit	..	..	..	30.1	Grape fruit	..	..	..	40.8
Shaddock	..	..	..	22.4	Shaddock	..	..	..	34.3
Hybrid Lemon.	..	..	..	17.3	Hybrid Lemon.	..	..	..	26.1

Diseases.—Records show that at 20 years of age there was about 25 per cent mortality due to *Phytophthora gummosis*, *Ganoderma lucidum* and *Ustilina zonata*. A disease survey at about the same age in 1951 showed that the Mandarin and Tangerine stocks were the healthiest, all three trees of each stock being free from any form of disease attack. The reported attack of Tristeza virus on the sour orange stock has not been subjected to any serious pathological test.

Grape fruit rootstock trial

The results are not very much different from those for sweet orange, except that the peak yield period appears earlier than in sweet orange. Tables I (b) and III (b).

CHAPTER X

REPORT ON THE PLANT QUARANTINE SERVICE

STATIONS

Ibadan

The running and maintenance of the plant quarantine greenhouses was taken over by the new Plant Introduction and Horticulture Section of the Botany Division on 1st October. Inspection of quarantined plants remains the responsibility of the Plant Pathology Division.

Lagos

Though still hampered by lack of staff and additional office facilities inspection of imported plant material has been carried on at Ikeja Airport, Apapa and Lagos.

Kano

Inspection work has been maintained at Kano despite continuing difficulties due to lack of junior staff quarters and office accommodation at Kano airport.

Kaduna

An Inspector has been on duty at Kaduna throughout the year.

Calabar

Shortage of staff made it impossible to re-open the office at Calabar. In planning the future development of the Service the authorised officers available will be posted at the following stations (in order of priority) Lagos (relief officer), Kano, Lagos (second relief), Port Harcourt.

PLANT IMPORTATION

Four hundred and ninety-six Import Permits were issued from the Ibadan Office during the year. As in the previous year over half of the permits were issued to private persons for restricted vegetable seeds and vegetative material of ornamentals.

The total number of consignments of plant material examined on importation at all stations was 3,964. Intercepted items included the following :—Maize, sunflower and tobacco seeds, cacao pods, sugar-cane cuttings, and ginger tubers, citrus and grape-vine plants.

PLANT EXPORTATION

At the beginning of the year a large number of requests for phytosanitary certificates were received from traders exporting food products to Ghana, although it was confirmed by the Ghanaian authorities that the certificates were not necessary. This was the reason for the exceptionally large number of certificates during the period. The situation has now been clarified and certificates for these exports are no longer being requested.

Export consignments which have been examined have included the following :—cacao budwood for Sudan and U.S.A., cacao seeds for Cameroon and Rhodesia, cacao and cola plants for United Arab Republic ; cowpea seeds for Ceylon, Malaya and U.S.A., groundnut seeds for Malaya and rubber seeds for Tanganyika.

STAFF TRAINING AND U.S.A.I.D. ASSISTANCE

The U.S.D.A. Course attended by Messrs Dosunmu and Obi was extremely valuable to them and the experience they gained on it has already stood them in good stead. U.S.A.I.D. has expressed further interest in the Plant Quarantine Service and has also helped in the provision of reference books on cultivated plants for the Ibadan Plant Quarantine Office.

CHAPTER XI

REPORT ON THE LIBRARY

LIBRARY SERVICE

Considerable time has been devoted during the year to making good the accumulated arrears of Departmental Publications. The last Annual Report published by the Department was that for 1959-60 ; Annual Reports for 1960-61, 1961-62 and 1962-63 are now in the press, and should shortly be available for distribution. Twenty-one Memoranda have been received for publication, of which ten have been issued, and eleven are in course of preparation. The Quarterly Research Bulletin has been issued regularly throughout the year.

The recording of serial titles held in the Library has continued, and these now total 421. A valuable gift of periodicals from the Commonwealth Mycological Institute has greatly strengthened our holdings particularly in the plant pathology section, by providing runs of back numbers, and some useful new titles. Book accessions have totalled 203, and microfilm copies of journal articles 59. An index to microfilm and photocopy negatives held by the Library has been started.

Loan issues from the Library have totalled 1418 ; of these direct issues from the Library were 565, and loans of current periodicals and pamphlets by circulation 853. One hundred and thirty-four publications were obtained from external sources ; 75 were borrowed from local libraries, mainly from the Library of the University of Ibadan, to whom we are greatly indebted for their continued co-operation. The remainder were obtained as microfilm copies from overseas.

The distribution of FAO publications to other Federal Departments and Institutes has continued, and of Commonwealth Agricultural Bureaux reports received on behalf of the Director of Agricultural Research as Liaison Officer, to Official Correspondents in the Regions. The creation of Mid-Western Nigeria necessitated a re-allocation of CAB quota journals, and the co-operation of other Federal and Regional Departments has ensured the supply of one set of these journals to the new Region.

The Photographic Laboratory received 213 requests for its services during the year, for photographic records of laboratory specimens, field trials, publications, and tours of eminent visitors, such as the visit of the Hon. Minister of Economic Development to the University of Ibadan. The total number of photographic prints prepared was 3,861, of microfilms 35 and of Duostat photocopies 55.

The Drawing Office has prepared 58 blueprints, graphs and plans which have included the site plan for the Federal Rice Research Sub-station near Birnin Kebbi, the plan for the proposed Laboratory and Office for the Warri Rice Research Sub-station, and revised editions of plans of Moor Plantation and Federal Rice Research Station at Badeggi.

PUBLICATIONS

Scientific Journals

EIJNATTEN, C. L. M. van "A study of the development of two varieties of maize at Ibadan, Nigeria". J. Agric. Sci., 1963, **61**, 65-72.

GREGORY, J. L. "Observations on yams attacked by the yam beetle *Heteroligus Meles* (Billb.) (Col., Dynastidae)". Bull. ent. Res., November, 1963, **54**(3) 433-459.

MOUND LAURENCE, A. "Host-correlated Variation in *Bemisia tabaci* (Gennadius) (Homoptera : Aleyrodidae)". Proc. R. ent. Soc., London December, 1963, **38A**, 171-180.

OKIY, G. E. O. "Experience with Freedom from Hunger Campaign Fertilizer Trials in Nigeria". A paper read at the World Food Congress, in Washington, D. C., June 1963.

- ROBERTSON, D. G. "Further Studies on the Host Range of Cowpea Yellow Mosaic Virus." *Trop. Agriculture, Trin.*, October 1963, **40** (4), 319-324.
- SLUYTERS, J. A. F. M. "Milling Studies on Parboiled Rice in Nigeria". *Tropical Agriculture, Trin.*, April 1963, **40** (2), 153.
- SLUYTERS, J. A. F. M. "A note on taste tests on rice in Northern Nigeria". *Neth. J. Agric. Sci.*, 1963, **11** (3), 183-187.
- WAITT, A. W. "Yams, *Dioscorea* species". *Field Crop Abstr.*, 1963, **16** (3), 145-157.

Memoranda

- No. 44. Observations on the yam beetle *Heteroligus meles* Billb. (Col.; Dynastidae) by J. L. Gregory.
45. Some more information on the variability of the tasselling time (period to anthesis) of maize by C.L.M. van Eijnatten.

Memoranda

- No. 46. Recording and numbering system used in the maize breeding section by N. N. Okparanta.
47. Plant virus diseases in Nigeria by D. G. Robertson.
48. The Efficiency of Phosphorus and Nitrogen Fertilisation in swamp rice on some Nigerian alluvial soils by Th. J. Bredero.
49. On the Cola Tree Borer in Nigeria *Phosphorus Virescens* (Olivier) Lamiidae by F. A. Square and F. O. Iwenjora.
50. Yam Beetle-Bionomics and Control by T. A. Taylor.
51. Preliminary Investigations on Field Pests of Cowpeas and methods of control by T. A. Taylor and F. O. C. Ezedinma.
52. Field Pests of Cowpeas by T. A. Taylor.
53. Some information about the small rice mills at Abakaliki Eastern Nigeria by J. A. F. M. Sluyters.
54. Selection of West African Varieties of maize for resistance to *cochliobolus heterostrophus* by Van Eijnatten.
55. Cassava investigations carried out in Northern Nigeria by M. J. Ekandem.
57. The acceptability of floury, and floury flint (dent) maize grains in Nigeria by Van Eijnatten.
58. Laboratory Tests on the Effectiveness and Action of two insecticides in controlling Yam Beetles by T. A. Taylor.
63. Plant Introduction 1962 by J. A. Obi.
64. List of Rubber Clones in Nigeria and their Distribution on 31-12-63 by J. A. Obi.
65. Some Data in Support of the Current Recommendations on Rice varieties for Northern Nigeria by J. A. F. M. Sluyters.

Special Publication

- OKIY, G. E. O. "Report on a Tour of Agricultural Research Centres in the United States of America, Canada and Trinidad, 1963".

APPENDIX I

METEOROLOGICAL STATION MOOR PLANTATION (0703.25B)

REPORT ON RAINFALL JANUARY TO DECEMBER 1963 (10 00 a.m.)

<i>Month</i>	<i>Rainfall in inches</i>	<i>10 Years Average in inches</i>	<i>No. of wet days</i>	<i>Cumulative total in inches</i>
JANUARY	—	0.25	—	—
FEBRUARY	2.41	1.05	7	2.41
MARCH	2.20	4.29	6	4.61
APRIL	3.64	5.10	10	8.25
MAY	5.13	6.17	11	13.38
JUNE	10.24	7.97	20	23 62
JULY	9.19	5.05	18	32.81
AUGUST	13.35	3.48	20	46.16
SEPTEMBER	8.99	6.16	18	55.15
OCTOBER	8.62	7.81	18	63.77
NOVEMBER	1.10	2.64	5	64.87
DECEMBER	0.65	0.33	2	65.52
TOTAL	65.52	50.30	135	380.55

APPENDIX II

METEOROLOGICAL STATION—MOOR PLANTATION (0703.25B)

REPORT ON SUNSHINE JANUARY TO DECEMBER 1963 (6.00 a.m. to 6.00 p.m.)

<i>Month</i>	<i>Duration of Monthly Sun- shine in Hours</i>	<i>Mean Duration of Sunshine in Hours</i>
JANUARY	234.4	7.56
FEBRUARY	205.9	7.35
MARCH	192.4	6.21
APRIL	176.8	5.89
MAY	162.2	5.23
JUNE	192.0	6.40
JULY	154.1	4.97
AUGUST	100.1	3.71
SEPTEMBER	129.1	4.45
OCTOBER	158.2	5.10
NOVEMBER	196.9	6.56
DECEMBER	209.2	6.75
TOTAL	2111.3	70.18
MEAN	175.9	5.85

METEOROLOGICAL STATION—MOOR PLANTATION (0703.25B)
REPORT ON RAISED AND SUNKEN EVAPORATION TANKS

JANUARY TO DECEMBER 1963

<i>Month</i>	<i>Raised Rank Evaporation</i>			<i>Sunken Tank Evaporation</i>
	<i>No. of cups Added</i>	<i>No. of cups withdrawn 10.00 a.m.</i>	<i>Evaporation in inches 10.00 a.m.</i>	<i>Evaporation in inches 10.00 a.m.</i>
JANUARY	192	—	3.84	3.84
FEBRUARY	178	56	4.85	4.85
MARCH	223	60	5.46	5.46
APRIL	178	123	4.74	4.74
MAY	144	164	4.73	4.73
JUNE	88	330	5.40	5.40
JULY	98	324	4.67	4.67
AUGUST	71	371	7.35	7.35
SEPTEMBER	96	295	4.91	4.91
OCTOBER	95	280	4.92	4.92
NOVEMBER	168	30	3.86	3.86
DECEMBER	180	16	3.93	3.93
TOTAL	1711	2049	58.66	58.66
MEAN	143	171	4.89	4.89

METEOROLOGICAL STATION MOOR PLANTATION (0703.25B)
REPORT ON TEMPERATURE DATA
JANUARY-DECEMBER, 1963.

Month	10.00 A.M.										4.00 P.M.									
	Mean Maxi- mum °F	Mean Mini- mum °F	Mean Dry °F	Mean Wet °F	Mean Rela- tive Humi- dity %	Mean Grass Mini- mum °F	Mean Earth 1 Ft. °F	Mean Earth 4 Ft. °F	Mean Dew Point °F	Mean Vapour Pressure MBS	Mean Anemo- meter Runs Miles	Mean Water Maxi- mum °F	Mean Water Mini- mum °F	Mean Dry °F	Mean Wet °F	Mean Rela- tive Humi- dity %	Mean Earth 1 Ft. °F	Mean Anemo- meter Runs Miles	Mean Dew Point °F	Mean Vapour Pressure MBS
January	91.9	71.9	79.9	76.0	83.1	68.5	86.3	85.7	74.2	28.9	7.99	89.0	68.3	91.2	78.1	54.4	87.7	7.08	72.2	27.0
February	93.7	72.7	81.0	76.5	81.1	70.6	87.0	87.2	74.4	29.2	16.21	89.9	68.4	91.9	78.4	54.0	89.0	59.16	70.0	27.2
March	93.7	71.3	81.3	76.0	78.1	69.8	86.5	87.3	73.5	28.5	46.97	91.4	67.6	91.6	77.5	51.6	88.8	47.01	70.8	26.0
April	90.9	72.0	81.4	77.2	82.3	71.5	86.6	87.7	75.6	30.0	49.40	91.3	68.4	88.6	78.7	64.7	89.1	49.26	74.5	29.4
May	89.7	72.7	81.4	77.0	81.5	72.1	85.8	87.1	75.0	29.7	44.24	89.7	69.2	86.3	78.7	70.9	88.1	43.94	75.0	30.0
June..	88.5	70.9	79.5	75.8	84.3	70.9	84.6	86.3	74.8	28.9	45.39	88.9	67.9	85.6	78.1	70.8	86.6	45.42	74.9	29.5
July	85.9	71.4	78.0	74.6	84.7	71.3	83.0	85.1	73.1	27.7	52.66	86.7	67.1	82.9	71.3	77.8	84.9	52.88	75.1	29.6
August	84.4	71.7	76.8	74.1	87.9	71.6	81.6	83.6	72.9	27.6	55.33	85.4	67.1	81.9	77.2	80.8	82.9	55.16	75.3	29.9
September	87.2	71.4	77.4	74.7	87.9	71.9	82.9	83.4	73.5	28.1	44.62	87.8	67.8	84.7	78.2	74.5	84.6	44.16	75.4	30.1
October	88.0	71.3	78.9	75.4	84.5	71.4	83.5	84.4	73.9	28.5	36.68	88.7	68.3	84.2	77.7	74.5	85.7	36.74	75.0	29.6
November	89.9	69.6	79.7	75.9	83.4	68.2	83.9	85.0	74.1	28.9	21.90	90.7	68.9	87.8	78.9	66.5	86.1	21.37	75.1	29.8
December	91.7	70.9	80.1	76.3	83.3	69.3	85.9	86.0	74.7	29.2	26.66	88.8	69.0	90.2	78.1	57.6	88.1	26.57	72.9	27.7
TOTAL	1,075.5	857.8	955.4	909.5	1,002.1	847.1	1,017.6	1,028.8	889.1	345.2	448.05	1,068.3	818.0	1,046.9	930.9	798.1	1,041.6	488.75	886.2	345.8
MEAN	89.6	71.5	79.6	75.8	83.5	70.6	84.8	85.7	74.1	28.8	37.34	89.0	68.2	87.2	77.6	66.5	86.8	40.73	73.9	28.8

METEOROLOGICAL DATA FOR FEDERAL RICE RESEARCH
STATION, BADEGGI: 1963

<i>Month</i>	<i>Rainfall (in) Badeggi</i>	<i>Days of Rain- fall</i>	<i>Cumula- tive Mean Total (in.)</i>	<i>Relative Humi- dity 0900 GMT (percen- tage)</i>	<i>Maximum Tempera- ture (°F)</i>	<i>Minimum Tempera- ture (°F)</i>	<i>Mean Tempe- rature (°F)</i>
January ...	0.00	—	0.00	61	94.1	63.0	78.6
February ...	0.05	(1)	0.05	67	97.8	72.1	85.0
March ...	0.94	(4)	0.99	47	98.0	71.6	84.8
April ...	2.55	(6)	3.54	67	95.8	76.1	85.9
May ...	5.90	(7)	9.44	74	92.9	76.0	84.4
June ...	10.51	(13)	19.95	79	89.5	73.8	81.7
July ...	10.47	(19)	30.42	82	87.9	73.7	80.8
August ...	8.76	(18)	39.18	84	87.4	73.8	80.6
September ...	7.45	(16)	46.63	80	88.9	73.7	81.3
October ...	6.42	(12)	53.05	80	89.0	73.8	81.4
November ...	0.00	—	53.05	73	92.4	68.7	80.5
December ...	0.00	—	53.05	74	93.5	63.0	78.3
TOTAL ... =	53.05	(96)	—	—	—	—	—
MEAN ... =	—	—	—	72	92.3	71.6	81.9

